Object Based Land Cover Extraction Using Open Source Software

Abhasha Joshi[1], Janak Raj Joshi[2], Nawaraj Shrestha[3], Saroj Sreshtha[4] , Sudarshan Gautam[5]

[1] Instructor, Land Management Training Center, Dhulikhel Kavre, Nepal. theabhash@gmail.com
[2] Director, Land Management Training Center, Dhulikhel Kavre, Nepal. janakrajjoshi@gmail.com
[3] Lecturer, Kathmandu University Nepal. nawa.shrestha@gmail.com
[4] MTECH Student, University of Technology, Sydney, Australia. saroj_shres2005@yahoo.com
[5] Training Chief, Nepalgunj Technical School, Nepalgunj, Nepal. sudarshangtm00@gmail.com

Keywords

Land Cover, OBIA, Segmentation, Spring

Abstract

Land cover is observed bio-physical cover of the earth's surface and is an important resource for global monitoring studies, resource management, and planning activities. Traditionally these land resources were obtained from imagery using pixel based image analysis. But with the advent of High resolution satellite imagery and computation techniques these data are now widely being prepared using Object based Image Analysis (OBIA) techniques. But mostly only algorithm provided in commercial software and Ecognition in particular is being used to study OBIA.

This paper aims to assess the application of an open source software Spring for OBIA. In this Study 0.5 meter pan sharpened Geo-Eye image was classified using spring software. The image was first segmented using region growing algorithm with similarity and area parameter. Using hit and trail method best parameter for segmentation for the study area was found. These objects were subsequently classified using Bhattacharya Distance. In this classification method spectral derivatives of the segment such as mean, median, standard deviation etc. were used which make this method useful. However the shape, size and context of the segment can't be accounted during classification. i.e. rule based classification is not possible in spring.

This classification method provides satisfactory overall accuracy of 78.46% with kappa coefficient 0.74. This classification method gave smooth land cover classes without salt and pepper effect and good appearance of land cover classes. However image segmentation and classification based on additional parameters such as shape and size of the segment, contextual information, pixel topology etc may give better classification result.

1. Introduction

The most common application of remote sensing is to produce thematic maps, such as those depicting land cover, using an image classification. Simply, land cover (LC) refers to the things what we see through the eyes covering the land. It is the observed (bio)-physical cover of the earth's surface (Di Dregorio & Jansen, 1997). It is the complex mixture of natural and anthropogenic influences and is the composition and characteristics of land surface elements (Cihlar, 2000). These natural and anthropogenic influences results into the classes such as forest, water, wetland, agriculture, built-up etc. in the land cover map.

Knowledge of land cover is an essential component for modeling the earth as a system and is important for many planning and management activities.

Extraction of land cover information from satellite imagery can achieved either by visual image interpretation or using digital image classification approaches. The first global land cover map compiled from remote sensing was produced in 1994 from maximumlikelihood classification of monthly composited AVHRR normalized difference vegetation index (NDVI) data. . (Defries & Townshend, 1994)

Image classification is traditionally done using pixel based classification approaches. But the continuously improving spatial resolution of remote sensing (RS) sensors sets need for development of new methods utilizing this information to making the accurate land use map. In high resolution satellite imagery it is possible to extract information using additional variables such as shape, texture, and contextual relationships besides grey value of pixel which is known as Object Based Image Analysis (OBIA). Assessing the properties of segments by using spatial, spectral and temporal scale is Object Based Image Classification (Blaschke, 2009). The main premise of OBIA is that image pixel are first grouped into objects that corresponds to the real world feature and subsequently classifying these objects based on shape, size, texture, pattern and statistical derivatives of spectral value of objects.

Significant researches have been done in past years about OBIA but most of them used commercial software and Ecognition in particular. Thus this paper aims to highlight the application of an open source software Spring for OBIA of High Resolution Satellite Imagery. The objectives of this study are to

ι) Classify High resolution image using OBIA to extra land cover applying open source software.

ιι) To assess the accuracy of this classification method

2. Study Area and Data

The study area of about 6 km * 7 km is selected a portion of Chitwan and Nawalparasi district of Central development region. River Narayani flows from the boundary of above two districts The study is heterogeneous with all major land cover types such as wetland, forest, built-up, agriculture land, river, pond, etc. The study area lies in extent between $27^0$38’48” latitude and $84^0$19’22” longitude to $27^0$42’39” latitude and $84^0$23’03” longitude.

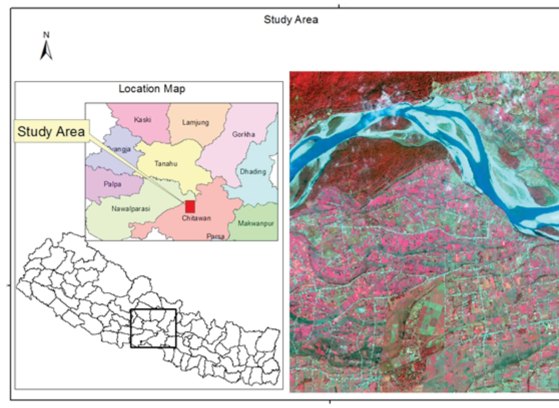

Figure 1: Study Area

Major data that was used in this project was GeoEye image of the study area. It contained Red, Green, Blue and NIR bands. The spatial resolution for panchromatic image is 0.5 m and that for multispectral band is 2.0 m. The dynamic range of each band is 11 bit. The image was acquired on 27th December 2010. We obtained the image of our study area from National Land Use Project based in Thapagaun in Kathmandu valley.

Other data used in this study is topographic data produced by Survey Department.

3. Methodology

Image Preprocessing

Preprocessing is done before the classification of image to remove and minimize the radiometric and geometric errors. Radiometric corrections include correcting the data for sensor irregularities and unwanted sensor or atmospheric noise, and converting the data so they accurately represent the reflected or emitted radiation measured by the sensor. Geometric corrections include correcting for geometric distortions due to sensor-Earth geometry variations, and conversion of the data to real world coordinates. (Janssen, Weir, Grabmaier, Kerle, Parodi, & Prakash, 2001). Road layer of topographic map was used for the rectification of the satellite image. Road junctions were identified in the image and 12 such points were used. Affine transformation was used to generate new grid for the rectified image. To assign the pixel value for these grids nearest neighborhood algorithm was used.

Image transformation was also used for extraction of features during classification. NDVI, NDWI and Grey-Level Co-occurance Matrices (GLCM) texture were derived for different bands for achievement of higher accuracy in image classification.

Segmentation

Segmentation is defined as the process of completely partitioning a scene (e.g. a remotely sensed image) into non overlapping regions in scene space (e.g. image space) (Schiewe j., 2002). The basic task of segmentation algorithm is the merge of (image) elements based on homogeneity parameter or in the differentiation to neighboring regions (heterogeneity), respectively (Schiewe J., 2002).

Region growing algorithm of Spring was used for segmentation in this project. It makes object with parameter defined by similarity and area. In this algorithm segmentation process starts with seed points. Then similarity criteria are computed for each spatially adjacent region. The similarity criteria are based on a statistical hypothesis test, which checks the average among regions. Then regions are merged into bigger objects as long as the cost is below the similarity value. For the union of two neighbor regions A and B, the following criteria are adopted in spring:

- A and B are similar (average test);
- The similarity reaches the limit defined;
- A and B are spatially close (among the A neighbors, B is the closest, and among the B neighbors, A is the closest).

While segmenting experiment with different parameters was done. Human interpretation and correction is considered as the best way to evaluate the segmentation (Fardia, Royta, Shawakat, & Husnain, 2005) and thus we also followed the same approach to evaluate the segmentation results.

Different parameters for segmentation were tested by hit and trial method until the objects obtained relatively matched the land cover patches.

Figure 2: Segmentation with parameter 10-50

Segmentation with similarity 25 and area 40 (Figure below) worked best in image used in this project. It gave the best compromise between the number of objects and individual land cover information. So the study area was segmented using this parameter.

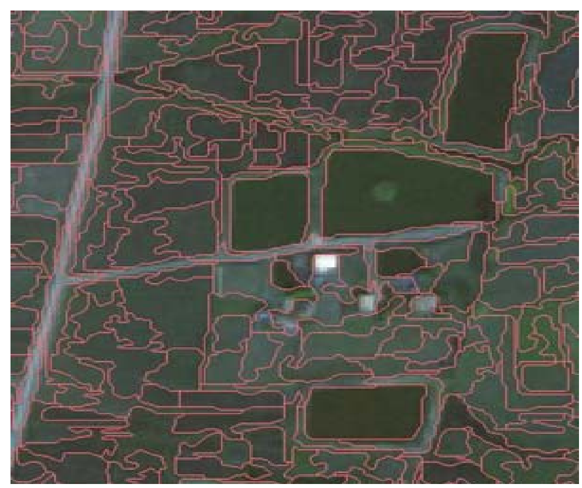

Figure 3: Segmentation with Parameter 25-40

Object Based Image Classification

Supervised classification using Battacharya algorithm was done for this study. Priori classification with seven land cover classes viz. Bare Cultivation, Built-up, Green Cultivation, Forest, Water, Wetland and Sand were selected for the classification. For this first the training data had to be provided. In statistics, the Battacharya distance measures the similarity of two discrete or continuous probability distributions (Battacharya, 1943).That is, it measures the average distance between the spectral classes' probability distributions. The misclassified objects were reassigned to its proper class in the training data and again reclassification was performed in order to refine the land cover classes.

As, it is a supervised classification process which unifies advantage of manual and statistical approach, rather than delineating training areas sample objects are iteratively selected. These sample objects should have the most representative and clearly distinguished features (Lang, 2005).

RESULT AND DISCUSSION

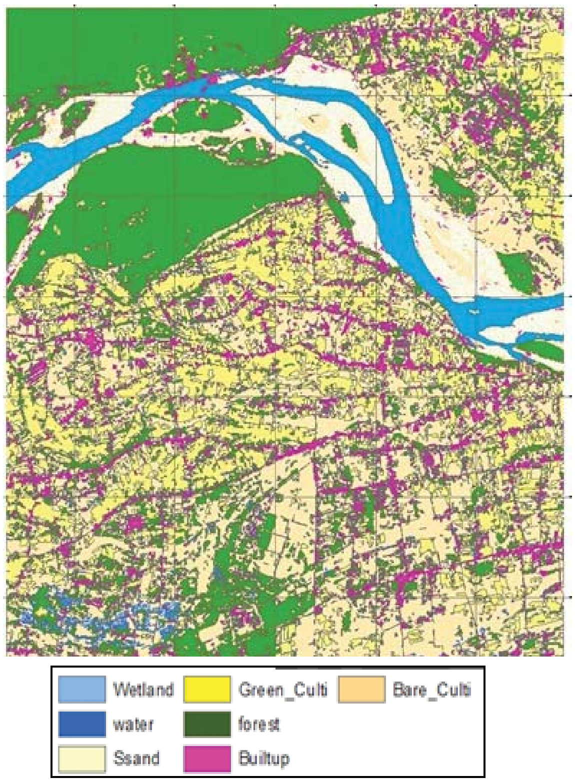

Figure 4: Land Cover

In this study we perform object based image analysis by making object based on size and similarity parameter and classifying them based on the spectral values and their statistical derivatives. This classification method gave smooth land cover classes without salt and pepper appearance. Figure 4 shows the classification result of OBIA with various land cover distribution in map and Figure 5 shows the pattern of land cover in the study area statistically.

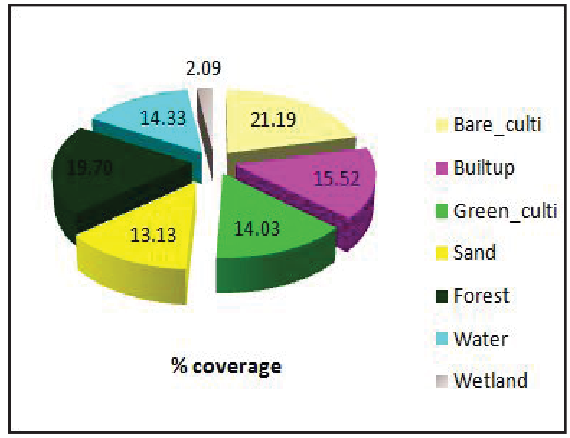

Figure 5: Land Cover Pattern

In order to assess the acuracy, 150 sample points of ground truth collected randomly in the field weere used. The overall accuracy and Kappa statistics from the classification (Table 1) shows that the method can be used for assessemnt of landcover classification. The classification has overall accuracy of 78.6% and Kappa coefficient of 0.74 showing that the results fit the purpose. The higher accuracy of water and forest is due to result of the use of indices such as NDVI, NDWI and texture as supplement in image classification.

Table 1:Confusion Matrix

Accuracy	Land cover types						
	Bare_ Cultivation	Builtup	Green_ Cultivation	Sand	Forest	Water	Wetland
User's accuracy (%)	59.42	83.82	86.11	97.06	65.71	97.56	100.00
Producer's accuracy (%)	87.23	85.07	56.36	70.21	95.83	80.00	63.64
Overall accuracy= 78.46% , Kappa Coefficient= 0.74							

CONCLUSION

Thus this method of OBIA using open source software Spring provides satisfactory overall accuracy of 78.46% with kappa coefficient 0.74. Since real world object are assigned to a class one can get accurate and good visual appearance land cover patches.

The major limitations while classifying using this method is that the shape, size and context of the segment can't be accounted during classification.

Therefore rule based classification is not possible in spring. However spectral derivatives of the segments such as mean, median, standard deviation etc. can be used which makes it useful. The limitation however was accounted by the use of image derivatives such as NDVI, NDWI and GLCM texture.

Land cover classification using free and open sources software greatly reduces the cost of remote sensing applications. But such software requires patience and extensive troubleshooting. Some computer skills are required to make this process successful. Functionalities and algorithms in Spring are also limited in comparison to other commercial image analysis software. Image segmentation and classification based on additional parameters such as shape and size of the segment, contextual information, pixel topology etc may give better classification result. However these functionalities can be added to Spring since it is an Open Source Software.

References

Battacharya, A. (1943). On a measure of divergence between two statistical populations defined by their probability distributions. Bulletin of the Calcutta Mathematical Society , 99-109.

B Blaschke, L. t.(2006). Object based image analysis for automated information extraction. ISPRS Journal for Photogrammetry and Remote Sensing .

Cihlar, J. (2000). Land Cover Mapping of Large Areas from Satellites:Status and Research Priorities. International Journal of Remote Sensing , 1093-1114.

Defries, R., & Townshend, J. (1994). NDVI derived land coverclassification at global scale. International Journal of Remote Sensing , 5.

Di Dregorio, A., & Jansen, L. (1997). A New Concept for a Land Cover Classification System. Alexzendria.

Fardia, P., Royta, N., Shawakat, A., & Husnain. (2005). Evaluation of Aster Spectral Bands For Agricultural Land Cover Mapping Using Pixel-Based And Object-Based Classification Approcah.

Janssen, Weir, Grabmaier, Kerle, Parodi, & Prakash. (2001). In Principles of Remote Sensing (pp. 129-155). Enschede: The International Institute of Geo Information Science and Earth Observation.

Schiewe, J. (2002). Segmentation of High Resolution Remotely Sensed Data Concepts, Application And Problems. Germany.

Schiewe, j. (2002). Segmentation of high-resoluiton remotely sensed data . ISPRS Journal of Photogrammetry and Remote Sensing .

Principal Author's Information

Name	:	**Mr. Abhasha Joshi**
Academic Qualification	:	BE in Geomatics Engineering, KU.
Organization	:	Land Management Training Center, Dhulikhel
Current Designation	:	Instructor
Work Experience	:	2 Years
Published Papers/Articles	:	One

Email : theabhash@gmail.com