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Image Classification for Different Land use and Land Covers of East Champaran District using Maximum Likelihood Technique

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Abstract: Land use and land cover classification of LISS III image of East Champaran district of Bihar of October 2011 for different classes such as agricultural land, fallow land, dense buil-up, low built-up, wet land and barren land using maximum likelihood supervised classification technique. The district is located between 26^{0} 15′ to 27^{0} 01 N latitudes and 84^{o} 28 E to 85^{o} 18 E longitudes. The total area of the district is 4155 sq. km. Satellite imagery has been downloaded from different web sites and clipped to study area. The clipped image of the district has been georeferenced and used for classification for identified land use and land cover classes. It is observed that the agricultural land area is 2754.82 Sq Km, fallow land area is 672.34 Sq Km, barren land area is 86.58 Sq Km, wet land area is 146.48 Sq Km, dense built-up area is 25.36 Sq Km and low built-up area is 282.18 Sq Km, , and. The producer, user, overall accuracies and Kappa coefficient have been calculated from confusion/ error matrix. It shows that the overall accuracy is 91.62% and Kappa accuracy is 90.45%.

Keywords: Image, classification, class and accuracy

INTRODUCTION

Land-use and land-cover are two different things in its signification. Land-use refers to land's social properties that is the output of reconstruction activities that human adopts to manage and regulate the land according to determinate economic and social purpose. Land-use is a process of converting natural ecosystem into social ecosystem such as agricultural land, built-up areas, etc. Land-cover emphasizes particularly the reflection of various elements on earth surface covered with natural body such as water body, natural vegetation, barren land, etc. The knowledge of land use and land cover information is essential for proper management and planning of natural resources (Zhu, 1997). it is a desired input for many agricultural and ecological models. Classified map and repetitive coverage, satellite remote sensing imagery is a necessary source of gathering quality land cover information at local, regional and global levels (Csaplovics, 1998; Foody, 2002). Due to changes in environmental conditions, there is a change in spectral characteristics from one region to the other (Arora and Mathur, 2001). Classification on the basis of spectral data from a remote sensing sensor alone may not be sufficient to gather effective land use/ land cover information. A classification approach that incorporates data from different sources may be more effective than that is based solely upon the multispectral data from a single remote sensing sensor. The classification has been performed using the most widely used Maximum Likelihood Classifier (MLC).

The present study is based on mapping land cover from IRS-1C remote sensing data of East Champaran. The LISS III multispectral image

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(23.5 m spatial resolution) has been used as the primary data to produce land cover classification. Images are georeferenced and classified for different land use and land covers (LULC) of East Champaran district of Bihar has been done. The main LULC classes are agricultural/ crop land, fallow land, barren land, wet land, dense builtup area (urban area) and low builtup (rural area). Wet land mainly covers wet area from rivers, ponds and lakes where as barren land is mainly situated by the side of rivers. Agricultural land, fallow land, barren land and wet land come uder pervious categories where as dense builtup and low builtup come under impervious categories of land use and land cover classes. LULC classified images are useful to farmers to do agricultural activities in right way, right place and right time to produce more and ultimately income is increased to farming community of this area. (land cover classification using LISS II-PDF)

MATERIALS AND METHODS

There are various data processing steps are involved to perform image classification. The main steps are data preprocessing of LISS III image is to correct atmospheric errors, geometric correction of LISS III images then generation of ancillary data layers, image classification and accuracy assessment. Accuracy assessment has been done using error/ confusion matrix. The atmospheric error is common in remote sensing data and is mainly in the shorter wavelength regions as in blue. The effect of atmospheric error is due to additional spectral values of the ground reflectance (Gupta, 2003; Jensen, 1986). In this study, the LISS III image of study area was corrected for atmospheric errors using dark object subtraction method (Chavez, 1988). Geometric correction of images is also a pre-requisite to perform iamge classification. LISS III image of study area was geometrically corrected using well-distributed ground control points (GCPs) on the image. After preprocessing of images, georeferencing is done and finally images of October 2011 of East Champaran district (study area) has been classified using supervised maximum likelihood classification (MLC) technique for six different land use and land cover classes viz. agricultural/ crop land, fallow land, dense builtup low builtup, wet land and barren land.

Maximum likelihood classification (MLC) and AOI creation

Over the years, a number of image classifiers have been developed. Maximum likelihood classification (MLC) is one of the most accurate and commonly used image classification techniques. This technique is based on the decision rule that the unknown class pixels are allocated to those class which they have the highest likelihood of membership (Foody *et al*., 1992). MLC has been used here to classify images of study area in supervised mode for different land use/ land cover classes. Different training samples were collected for the six identified classes/ categories for training signatures for the classification of images of October 2011. Areas of interests (AOI) were created for different land use and land cover classes and these AOIs were saved as signatures in a signature file, which is used for the classification of the images of study area.

Classification accuracy assessment

Accuracy assessment is essential in the classification process. The accuracy of classification has been computed through error matrix or confusion matrix. Error matrices compare different categories of an automated classification with the known reference data or ground truth (Congalton and Green, 1999). The accuracy of various categories which is also known as classification accuracy mainly indicates to what extent a category is correctly mapped on the remotely sensed data or image with reference to its geographic location on the ground. Producer's accuracy, user's accuracy, overall accuracy and the Kappa coefficient were determined from the confusion matrix (Jensen and Van der wel, 1994). Therefore, in this study, producer's accuracy (PA), user's accuracy (UA), overall accuracy (OA) and Kappa coefficient have been determined with the help of confusion matrix/ error matrix of the classified images of October 2011 of East Champaran district of Bihar. Producer's accuracy and user's accuracy were determined for all six land use and land cover classes.

RESULT AND DISCUSSION

The results determined from the classification of the different image datasets are discussed below keeping in view of the objectives of the present research. The producer's accuracy and user's accuracy of the different land use and land cover categories and overall accuracy and Kappa coefficients of the entire image determined from the classification of LISS III images of the study area of October 2011 using the training signatures are shown in the Tables 1-2 and Figs. 1-2. Area of different LULC classes is also shown in Table 3 and Fig. 3. The PA, UA, OA and Kappa accuracy/ coefficient were determined with the help of confusion / error matrix.

Table 1: Summary of the producer accuracy (%) and user accuracy (%) of different land use and land cover classes/ categories determined from the classification of images of October 2011 of East Champaran using maximum likelihood technique

Classes/ categories	*Producer Accuracy*	*User Accuracy*
Agricultural land	96.37	95.16
Fallow land	94.72	93.64
Barren land	91.63	92.76
Wet land	90.58	91.62
Dense builtup	89.34	88.68
Low builtup	86.92	87.94

Table 2: Summary of the overall accuracy and kappa coefficient (%) of classified images of October 2011 of East Champaran using maximum likelihood technique

Year	*Overall Accuracy*	*Kappa Accuracy*
2011	91.62	90.45

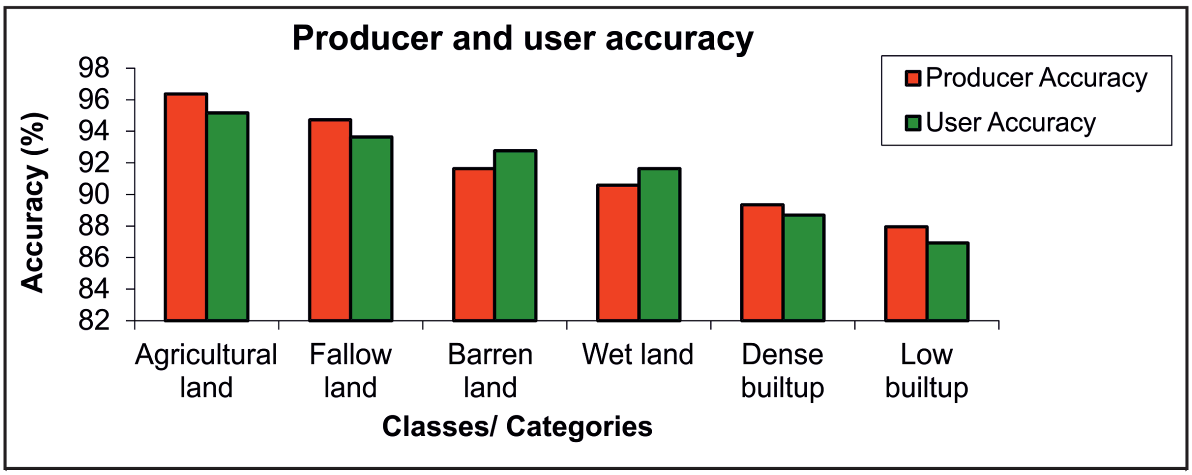

Fig. 1: Summary of the producer accuracy (%) and user accuracy (%) of different land use and land cover classes/ categories determined from the classification of images of October 2011 of East Champaran using maximum likelihood technique

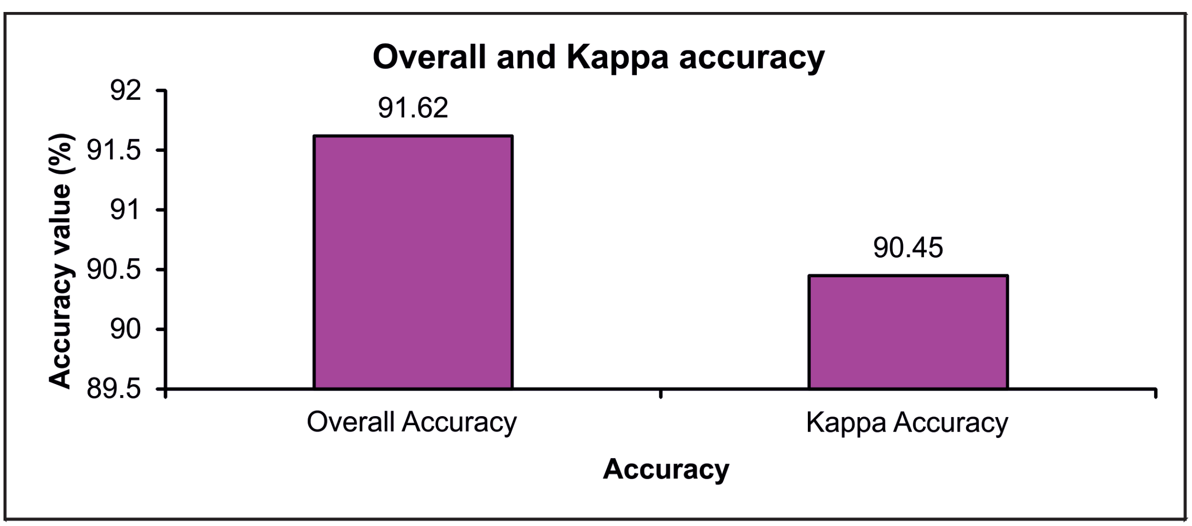

Fig. 2: Summary of the overall accuracy and kappa coefficient (%) of classified images of October 2011 of East Champaran using maximum likelihood technique

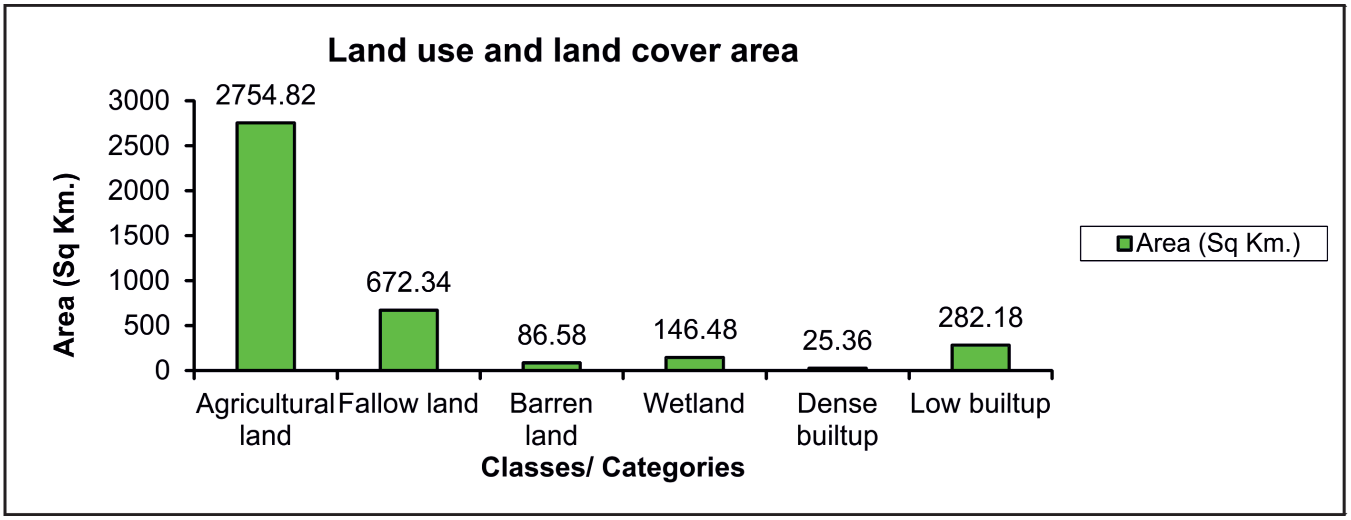

Fig. 3: Area of different land use and land cover classes of classified images of October 2011 of East Champaran using maximum likelihood technique

Table 3: Area of different land use and land cover classes of classified images of October 2011 of East Champaran using maximum likelihood technique

Classes/ categories	*Area (Sq Km.)*
Agricultural land	2754.82
Fallow land	672.34
Barren land	86.58
Wetland	146.48
Dense builtup	25.36
Low builtup	282.18

Agricultural land exhibits highest producer and user accuracy, then fallow land, barren land shows third highest accuracy, wet land shows fourth highest, dense builtup fifth highest and low builtup exhibits the least accuracies among all land use and land cover classes. The value of overall accuracy is 91.62% and Kappa accuracy is 90.45. The value of overall and Kappa accuracy are above 90% that specifies that the classification of image is accurate and almost matches to real situation that present on the surface of earth.

CONCLUSION

Pervious categories exhibit higher accuracies than the impervious categories. The producer and user accuracies of agricultural land is the highest and low built-up exhibits the lowest accuracies because less mixed pixels are present in agricultural land class where as the maximum mixed pixels are present in the low built-up category/ class. The image classification has been done by using maximum likelihood classification technique which provides overall accuracy and Kappa accuracy above 90% that means the land use and land cover classification is proper and accurate.

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