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Providing poplar plantation map by Indian remote sensing (IRS) satellite imagery in Northern Iran

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Using satellite imagery processing technique, we can separate planting poplar lands with a low cost, high speed and precision. The present study was conducted in northern Iran using Indian Remote Sensing (IRS) satellite data in July 2006 and ILWIS software to identify the cultivated surfaces of poplar. Field visitation recorded 548 ground control points by GPS in the way of features in various areas of Guilan Province. Ground control point map was overlaid on satellite color composite (sample sat) as training points map (pixels). In supervised classification, box classifier, maximum likelihood, minimum distance and minimum mahalanobis distance were used to determine user’s accuracy, overall accuracy and kappa coefficient of each method, separately. Results indicate that spectrum reflex of poplar species is different from other vegetations and separable; but it has very close interference with conifer forest, natural forest, rice field and canebrake. By determining suitable training points, poplar cultivated surfaces could be identified. Among the classification methods, maximum likelihood with 91.48% of overall accuracy and 90.75% of kappa coefficient is the best method for separating planting poplar lands compared to the other methods.

Key words: Poplar planting, supervised classification, maximum likelihood method, Indian remote sensing (IRS), Guilan.

INTRODUCTION

Developing wood farming through suitable variety of fast growing species cultivation is one of the basic methods of wood production. Intensive plantation and the use of inefficient lands through fast growing trees plantation are other ways of producing wood. Poplar species is one of the fast growing trees, that its cultivation is more considered in destroyed forests and also in plain land. Researchers have been able to produce approximately \( 30 \left( \frac{cm^3}{h} \right) \) by investigation of *Poplar delloides* and *Poplar euramericana* species during adobatioum experiments and various selections from different species. The detailed statistics obtained from cultivated surface of this species in various times can be an important factor in estimating the amount of wood produced by factories of wood industry and paper. Today, using of satellite imagery processing technique has created this facility for identification and interpretation of various phenomena of land by investigating the relationships that exist in their different areas. Satellite imagery elevation has created this facility to use computer for a more exact processing and extracting of the subject data.

The classification facility of spectral reflections is a unique characteristic used for determining the phenomenon called spectral reflection. Preparation of updated map is one of the good qualities (the big merits) of satellite imagery elevation classification which is very important in management. Therefore, by using satellite imagery, we could supervise the classification and hence determine the cultivated surfaces of poplar planting with high speed and precision. The main objective of this study is to supervise the classification index of poplar planting lands and poplar spectral reflexes resolution, and also preparation of updated maps of poplar planting lands. Among conducted studies in the field, we can refer to that of Spanner (1983) who combined the data of MSS...
and a digital elevation model in GIS. This method is a feasible independent classification based on topography (height and slope) and identification of orchards and natural vegetation that was not possible with only land sat data. Seubert et al. (1979) prepared land cover map by using a supervised classification and found it very useful in determining erosive limits of cultivated lands in America. Unal et al. (2004) classified cultivated land and separation of pistachio garden and orchard from the other vegetation in Gaziantep Province of Turkish. Ramos et al. (2007) tried to measure and identify soil movement in various gradient using GPS, GIS and DEM. Also, increased destruction during two past decades had been because of reducing vegetation. Rembold et al. (2000) investigated land cover changes in a 22 years period at Lakes Region in South of Ethiopia by aerial photographs (1972) and classifying TM land sat images (1994). The analyses indicate that cultivated surface had been increased and more erosion had occurred in new cultivated lands. Fletcher (2005) used high resolution QuickBird satellite images to recognize citrus with black mold (Capnodium citrinum) in Texas Region of America and indentifed it as a suitable method. Das et al. (2009) tried to prepare map for regions with reducing citrus production capacity in Meghalaya Region of India using IRS satellite images. The map of regions where citrus production capacity had been reduced was prepared using soil erosion information, vegetation condition and humidity tension.

The objective of this study is to determine the index and preparing map of poplar planting land. To carry out these aims, different methods of classification, various combinations of band and mathematic operation were conducted on bands and were compared together.

MATERIALS AND METHODS

Data collection

In the present study, LISS III sensor of IRS satellite data of July, 2006 with system rectification score of three spectral bands (B2.B3.B4) was used, with resolution measurement of 23.5 m; one band was used with 5.8 m resolution. To prepare the ground control points and accommodation of geometric imagery, topography digital maps in 1: 25000 scale was used.

Site of study

This research was conducted in the north of Iran in Guilan Province, with about 1471100 ha in plain area, middle area and highland; whose minimum and maximum altitude was 23 to 1400 m. Due to the variation of cultivated poplar in northern Iran, different sampling of surface of height, slope and aspect was used in this area. Poplar cultivated surface with Alnus glutinosa species was established in mixed forest most of the time. This is because of the proximity of poplar cultivated surface to the natural land. Sampling was conducted in four regions: Talesh, Ziabar, Khoshkenar in Western Province, Fouman in center, Safra baste (Astaneh Ashrafieh), Saravan (Rasht) and Siahkal in eastern Guilan Province.

At first, the large scale and rather pure cultivated poplar was identified by fieldwork on topography maps in different areas of Guilan Province. Due to investigation of supervised classification facility of IRS satellite images, the first step was georeferencing or in other words, geometric rectification of these images. Therefore by determining the exact positions of geographic and some other distinct points by GPS (Global position system), 23 points was introduced to software by the process of georeferencing. Field work was conducted to determine geographic exact position of surface land covers, especially planting poplar lands. Features were classified into 13:

1. Density rangeland
2. Grass field
3. Cloud
4. Conifer forest
5. Density forest
6. Modernity forest
7. Canebrake
8. Planting poplar lands
9. Rice field
10. Tea Garden
11. Maclura garden
12. Urban
13. Water sources

In field visitation and checking of the various features by color plot of region recorded 548 points by GPS. Because land surface vegetations have various usages in addition to planting poplar, in this research therefore, planting poplar land should be separated from these users by classifying the spectral reflexes of the various phenomena. Two methods have been used to separate planting poplar land in this study:

1. Unsupervised classification: At first in this method, the image pixels were put down in various groups or spectrum classification based on spectral identifications and by using statistical parameters such as mean and standard deviation. In the next step, the created spectral groups were classified automatically, based on their situation in image and regarding the number of the system desired classes. In this way, image was divided into 15 classes.
2. Supervised classification: To carry out the supervised classification, the first step is to determine the types of class and their numbers. This order is related to subject goals and data ability in the field. In order to separate the existing phenomenon in this research, it was divided into 13 classes. Once the classes were determined, the next step involved determining the training samples that played the main role in accuracy of classification. These samples needed to demonstrate the spectrum characteristics within the possible extent. Therefore, the selection of samples was determined through GPS, and field works determined the features limits that had a suitable surface scatting along the land (the minimum of 0.5 ha). These were then transferred to the computer, which comprised 97 point of Talesh region in western province, 16 point of Pishhesar in Fouman, 16 point of Safra Basteh, 32 points in Saravan, 45 points in Siahkal, 32 geographic points of Ziabar and khoshkenar in close proximity to Anzali wetlands. All information and sketch of region were recorded on the forms. In presentation of training points, spectral values scatting histogram for controlling and introducing the samples was used. Finally, in introduced training points, we used box classifier, maximum likelihood, minimum distance and minimum mahalanobis distance and supervised classification of satellite color composite for 13 classes of surface land cover. These images were calculated with ground control point, user's accuracy, overall accuracy and kappa coefficient of each method in preparing the surface land cover map. In this study, Arc GIs 9.2, ILWIS 3.2, Photoshop 7 and Excel 2000
Table 1. Confused matrix of maximum likelihood method.

<table>
<thead>
<tr>
<th>Rangeland</th>
<th>Grass</th>
<th>Cloud</th>
<th>Conifer</th>
<th>Forest</th>
<th>Forest 2</th>
<th>Fragmitus</th>
<th>Populus</th>
<th>Rice</th>
<th>Tea</th>
<th>Maclura</th>
<th>Urban</th>
<th>Water</th>
<th>Producer's accuracy</th>
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</table>

User's accuracy: 1.0 0.97 0.86 1.0 0.78 1.0 0.37 0.7 0.64 1.0 0.93 Overall accuracy 90.75%

The result of supervised classification

In this classification after presenting training points, the researcher tried to classify based on the introduced area. The spectral values scattering histogram was used to control the presentation of samples. The following methods were used to supervise classification of planting poplar lands:

Box classifier method

In this method with increasing threshold of standard deviation from 73 to 1/73%, user's accuracy decreased in classification of planting poplar lands. The greatest part of training pixels-poplar lands was classified in planting poplar vegetation class after classification and after that in agricultural lands, rice field and then in forest lands. The large number of classified pixels is related to water sources and after that to planting poplar lands. Box classification did not carry out the classification clearly and did not indicate vegetation, especially planting poplar land, well. User's accuracy was 81%, overall accuracy, 84% and kappa coefficient of this method was 85%; and the area of planting poplar indicated about 21000 ha which has great distance with existent statistics.

Maximum likelihood method

Table 1 indicated confused matrix of maximum likelihood method with various threshold of percent likelihood. This point is important that increasing of threshold does not impact on the change of class's accuracy and overall accuracy. This method has user's accuracy as 86.48%, overall, 91.48% and Kappa coefficient as 90.75%. The highest training point is placed after the water zones in planting poplar land and density rangeland. Figure 1 indicated the map of land.
classification by this method which shows better separation of land especially vegetation towards box classification.

**Minimum distance method**

Confused matrix of minimum distance with search radius of 1 m indicates that this method has no validity in preparing planting poplar lands map and surface vegetation. As a result less than 50% of area has been classified. In search radius of 10 m, user's accuracy in the classification of planting poplar lands was more and the large number of training points in this land was placed in this class, after the classification. The increase of the radius from 10 to 50 m did not change the accuracy of surface cover classes. In search radius of 100 m, the user's accuracy in classification of planting poplar lands is 77.55%, overall accuracy, 86.60% and kappa coefficient was 87.56%. Except search radius of 1 m, radius of 10, 50 and 100 m did not cause perceptible change in the user's accuracy and overall accuracy.

**Minimum mahalanobis distance method**

Confused matrix of Minimal Mahalanobis distance with search radius of 1m indicates that 94% of training points was classified in poplar class, accurately. More than 90% of training point in the planting poplar was classified in this class. Increasing the radius to 10, 50 and 100 m does not cause change in confused matrix. User's accuracy in this classification was 86% and overall accuracy was 88.18% and its kappa coefficient was 89.15%; and this had been interfering with rice which has close spectral reflection.

**Overall accuracy and Kappa coefficient**

Table 2 indicated user's accuracy, producer's accuracy, overall accuracy and kappa coefficient in various methods of classifying the satellite images, which can be used to compare the perception and accuracy of classifying the introduced features. Table 3 indicated the classified area of planting poplar lands in various
**Table 2.** Accuracy in different classification methods.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum mahalanobis distance</th>
<th>Minimum distance</th>
<th>Maximum likelihood</th>
<th>Box classifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>User’s accuracy (%)</td>
<td>86.01</td>
<td>77.55</td>
<td>86.48</td>
<td>81.10</td>
</tr>
<tr>
<td>Producer's accuracy (%)</td>
<td>83.77</td>
<td>79.47</td>
<td>84.54</td>
<td>83.1</td>
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<tr>
<td>Overall accuracy (%)</td>
<td>88.18</td>
<td>86.60</td>
<td>91.48</td>
<td>84.46</td>
</tr>
<tr>
<td>Kappa coefficient (%)</td>
<td>89.15</td>
<td>87.5</td>
<td>90.75</td>
<td>85.42</td>
</tr>
</tbody>
</table>

**Table 3.** Area of planting poplar land in different classification methods.

<table>
<thead>
<tr>
<th>Classification methods</th>
<th>Minimum mahalanobis distance</th>
<th>Minimum distance</th>
<th>Maximum likelihood</th>
<th>Box classifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area planting poplar land in site of study (ha)</td>
<td>47808</td>
<td>80783</td>
<td>40485</td>
<td>21196</td>
</tr>
</tbody>
</table>

methods obtained through the best methods of classification by comparing introduced surfaces in each one of the classified methods, kappa coefficient, and also by presenting the statistics on behalf of the executive organization.

**DISCUSSION**

Concerning the results obtained from the separation of poplar planning lands, at first by carrying out the unsupervised classification, the software divided the site of study into 15 classes. This work at the beginning is a suitable idea to start a classification, but by comparing this method of classification with ground natural point, it was not feasible for vegetation and separation of planting poplar land.

To carry out the supervised classification in presentation of training point, spectral values scattering histogram was used for controlling the presentation of ground picked up samples. In the input of the training control points, using picked up point by GPS in poplar planting lands and other ground features, it was observed that reflex of poplar is very close to other phenomena such as rice field, natural forest, conifer forest and canebrake. Therefore, due to separation of poplar planting lands and non-interference of spectral reflexes, the phenomenon close to poplar used the picked up training samples such as conifer forest, natural forest, rice field and canebrake more than other features.

But the probability of interference of spectral reflexes on the planting poplar lands is due to the closeness of these features with each other either in tone color or pixels value. This result is supported by Partovi (2000) who advocated for the separation of the various vegetations.

This subject (interference of spectral reflexes) has many problems in planting and management concerning land use. Incidentally, the result of classification was very complicated and made very hard the management of area and classes which is the main aim of this study. Poplar planting lands and their separation from other features become afflicted with error and low accuracy. In this study, four methods have been used for supervised classification. Box classifier method is not suitable to carry out the classification especially in separation of planting poplar lands. Minimum distance classification method is better than box classifier but not suitable for separation of planting poplar lands compared to other classification methods. This is due to decrease of user’s accuracy. Minimum mahalanobis distance method is better than the methods of box classifier and minimum distance in separation of planting poplar lands. But maximum likelihood method with 86.48% of user’s accuracy and 91.48% of overall and 90.75% of kappa coefficient is more suitable for separation of planting poplar lands because of its high accuracy, user’s accuracy, overall accuracy and kappa coefficient than the other classification methods. The result of Haghighi (2003) in separation of vegetation confirmed the use of this method.

The results of the present study thus suggest that by taking into account the training point, the ground control, and the use of the maximum likelihood method, we can identify the area for planting poplar lands in a shorter span of time and at lower cost.

**ACKNOWLEDGEMENTS**

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REFERENCES


