

LAND USE MAPPING USING ETM+ DATA (CASE STUDY: CHAMESTAN AREA, IRAN)

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ABSTRACT:

Land use maps are useful tools for agricultural and natural resources studies as a base data. Due to dynamism of natural resources, updating these maps is essential. Employing traditional methods through aerial photos interpretation to produce such maps are costly and time consuming. Satellite data is suitable for such purpose, as a consequence of its fast repeatability, wide and unique view and availability of data from most part of electromagnetic spectrum. The present study is conducted to investigate the capability of ETM⁺ data on land use mapping of Chamestan region, Mazandaran, Iran. The studied area was 67000 ha. Image of 18th July, 2000 were registered to 1:25000 digital topographic maps. Images were enhanced using contrast enhancement, False Color Composite (FCC), Principal Component Analysis (PCA), Tasseled cap transformation and vegetation indices. The Optimized Index Factor (OIF) and correlation technique were employed to determine the best band sets for FCC and consequently for classification analysis. Unsupervised (clustering) and supervised (maximum likelihood, minimum distance and parallelepiped classifiers) classification methods were used. Finally Hierarchical method was applied to increase maps accuracies. The results showed that contrast enhancement, FCC, PCA and Tasseled cap have effective role in features enhancement. Using the best bands set (156H) caused to highest accuracy in classification. In supervise classification, overall accuracy and Kappa coefficient for maximum likelihood classifier were estimate 85,83% and 62,81% respectively, for minimum distance method 73,77% and 47,12% and for parallelepiped 34,27% and 19,03%. The highest overall accuracy and Kappa coefficient related Hierarchical method is 94% and 84.89%.

INTRODUCTION

Land use maps are useful tools for agricultural and natural resources studies as a base data. Due to dynamism of natural resources, land use map updating is essential. Traditional methods utilization through aerial photos interpretation to produce such maps is costly and time consuming. Satellite data is suitable for such purpose, as a consequence of its fast repeatability, wide and unique view and availability of data from most part of electromagnetic spectrum.

Land cover map of the tropical forest rehabilitation was produced applying NDVI to TM data (Apan et al 1997). Also land use map of Mouk area, Iran was produced using Landsat data and GIS (Alavipanah et al 2001). Gomarasca (1993) assessed land use changes in the metropolitan area of Milan (Italy) employing maximum likelihood classification of TM data, aerial photo and topographic maps. Zahedifard (2002) produced land use map of Bazoft area, Iran, by means of TM data. She used maximum likelihood, minimum distance and parallelepiped algorithms for supervised classification. In addition hybrid method and GIS was implemented to improve the classification accuracy.

MATERIAL AND METHODS

The studied area is located in Mazandaran province, northern Iran, between 36° 14 to 36° 30 Longitude and 52° 0 to 52° 15 Latitude. Mean annual precipitation is 1200mm. The studied area was about 67000ha. Landsat ETM⁺ images of 18th July, 2000 were georeferenced to 1:25000 digital topographic maps by nearest neighbor resampling algorithm and the RMSe was

less than one pixel. Images were enhanced using contrast enhancement, False Color Composite (FCC), Principal Component Analysis (PCA), Tasseled cap transformation and vegetation indices. The Optimized Index Factor (OIF) and correlation technique were employed to determine the best band sets for FCC image and consequently for classification analysis. Unsupervised (clustering) and supervised (maximum likelihood, minimum distance and parallelepiped classifiers) classification methods were used. Finally Hierarchical method was applied to increase maps accuracy.

Hierarchical method: Assessing the supervised classification results has proved the high spectral similarities between rangelands and dry farmlands. Where the rangelands are located in south and the wheat dry farmlands are located in the north part of the studied areas. This similarity causes a low accuracy on classification results. The below mentioned hierarchical method was used to solve this problem. First of all, the rangelands and the dry farms were masked, and they were classified separately. Then the rest of the image was classified to the other features such as forest, rice fields, urban area and etc. Finally the whole classified land uses were integrated to develop the final map. Ground truth points were produced through field surveying with GPS as well as using topographic maps.

RESULTS AND DISCUSSION

The Landsat ETM⁺ image was classified to the nine different land uses (Table 1).

Table –1-area of different classes

Class	Area(ha)
Forest	44952.4
Rangeland	12236.7
Rice field	3951.2
Urban area	2599.6
Dry Farm	514
Water body	16.5
Wheat field	670.5
Shadow	1356.6
Cloud	369.2

To determine the best band set OIF and correlation method was used. The OIF results are given in Table (2).

Table –2-results of OIF

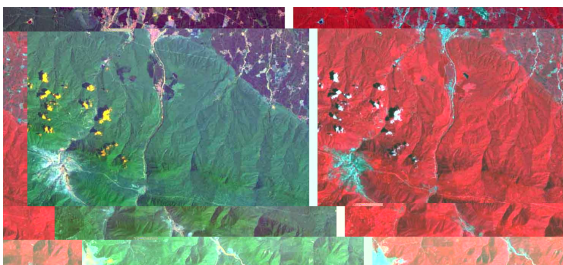
Category	Band set	OIF
1	2, 4, 6	46697.89
2	3, 4, 7	20121.29
3	1, 3, 4	2411.28
4	1, 4, 6	2358.39
5	2, 3, 4	2331.73
6	1, 4, 7	1614.67

Correlation among bands demonstrates that the bands 1, 5 and 6 are a suitable set for land classification. The classification accuracies by different band sets are presented in Table (3).

Table (3) Classification accuracies using different band sets

Band set	Accuracy	Band set	Accuracy
1, 5, 6	85.8	1,4,6	75.4
1,4,6,5	83.6	4, 3, 2, 5	73.2
All bands	81.2	1, 4, 7	70.2
4, 3, 2, 5, 6	80.4	4, 3, 2	67.8

According to above table the highest accuracy is allied to band set: TM1, TM5 and TM6. Where the band sets does not include the thermal band (TM6), spectral similarity between forests and rice fields are understandable, such as band set of TM4, TM3 and TM2 (Fig. 1) which these two land use can not be separated. During 18th July 2002 (The used image date), the rice fields has achieved their high biomass peak and the rice plants have covered the field completely, therefore spectral similarity occurs between forests and rice fields on visible bands such as TM2, TM3 and near infrared TM4. On the other hand, water can be detected with TM1 easily because it has a high reflectance on this band, whereas the forest absorbs the blue spectrum for photosynthesis.



FCC 156 FCC 432
Figure – 1- comparison between 432 and 156 false color composites

Also the water on the rice field causes a temperature reduction by evaporation which can be detected with TM6. But the forest canopy has only a common transpiration. So, due to this different water evaporation and water transpiration above them, various thermal characteristics of forest and rice field occur. Because of water accumulation on rice fields it is cooler than the forests. The temperature values of these two land use were calculated and few degrees of centigrade was recorded for forest canopy and rice field. The outcome results of this study confirm our claim about presence of thermal differences between forest and rice fields and it proves the other studies as well. Malingreau suggests that thermal band can show the thermal variation of various crown cover of the forests (Fallah Shamsi, 1997). Also Zobairi and Majd (1996) explain that one can separate two phenomenon using thermal bands when their reflectance is similar in visible bands. Also Alavipanah (2004) emphasizes on use of thermal band in earth sciences studies.

According to Table (3) the accuracy of classification is high when one uses TM1, TM5 and TM6 bands set, instead of using all bands for this kind of studies. It can be concluded that this is due to the high correlation among bands. Sabins (1996) states that high correlation among bands means replication of data. Maximum likelihood method has a good result on out coming maps. The overall accuracy and Kappa coefficient of this method is quite higher than the other algorithms such as: Minimum distance and parallelepiped classifiers (Table 4). According to this table the highest accuracy is related to Maximum likelihood classifier. Booth and Oldfield (1989), and Alvipanah et al. (2001) have emphasized on the priority of Maximum likelihood algorithm in compared to Minimum distance and parallelepiped classifiers.

Table (4) Accuracy of classification in different classification methods and algorithms

Classification Method		Overall Accuracy	Kappa Coefficient
Supervise	<i>Parallelepiped</i>	34.27	19.03
	<i>Minimum Distance</i>	73.77	47.12
	<i>Maximum Likelihood</i>	85.83	62.81
Hierarchical		94	84.89

According to Table (4) highest accuracy related to hierarchical method. Also Stanz (1987) used hierarchical classification and Darvishsefat (1997) used this method for forest and forest-stands classification.

This study showed that there is spectral similarity between rangelands and wheat fields. Sparse vegetation of rangelands

causes dominance of background soil reflectance on reflectance of vegetation. On the other hand in wheat fields since July is the time that wheat has been harvested hence there is no green vegetation and the majority of reflectance related to soil, there is confusion between rangelands and wheat field's reflectance.

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