Advances in Bioresearch
Adv. Biores., Vol 7 (1) January 2016: 53-60
©2015 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
ICV Value 8.21 [2014]

Advances in Bioresearch

ORIGINAL ARTICLE

Investigation of Land Cover/Use by the Use of Basic Pixel and Object Oriented Methods in Lands classification

Hamid Nouri[1]
Department of Climatology, Malayer University, Iran
Email: hamidwatershed@yahoo.com

ABSTRACT
Classification of satellite images is possible by the use of two scientific methods; the method of "basic pixel" which is based on classification of numerical values of images and the method "object oriented" which in addition to numerical values, uses data related to the content, texture and background in the classification process of images. The purpose of this study is to compare the classification algorithm of the maximum likelihood in the based pixel processing method with the closest neighbor algorithm in the object oriented processing for evaluation of classification performance of Landsat 8 satellite images. In order to compare the results, the land use map of Malayer city in Iran as an important place of the country for agricultural production and grape industry, was prepared by both methods of classification. The results indicate that with a 16% increase in precision of both overall accuracy and kappa for classification of satellite images, the object oriented method has a higher accuracy.
Keywords: *Land use, Landsat, Basic pixel, Object oriented, Malayer*

Received 12/09/2015 Accepted 18/11/2015

How to cite this article:
Hamid Nouri. Investigation of Land Cover/Use by the Use of Basic Pixel and Object Oriented Methods in Lands classification. Adv. Biores., Vol 7 [1] January 2016: 53-60**.** DOI: 10.15515/abr.0976-4585.7.1.5360

INTRODUCTION

Land use consists of a variety of land utilization to meet different human's needs. In other words, land use refers to the type of human' use of land and this type of use is also related to the land value and their natural specification [1]. Man has always been looking for identification of surroundings and its natural resources to achieve comfort and meet their needs. Knowledge of the types of land cover and human activities, as the basic information required for regional planning, is of utmost importance. Optimum, systematic and sustainable operation of natural resources needs precise and up to date recognition of land use. Thus, one of the basic pre-requisites for desirable use of land is knowledge about land use patterns and its changes over time [2]. Land use and cover maps where the type and spatial pattern of land use is specified are important for planning at the local and regional levels. In this regard, using conventional methods like land survey for preparation of land use maps is generally time consuming and costly. For this reason, today, as a result of time saving, lower cost than the conventional method, data being up to data and increase of precision and speed, the use of remote sensing technology and applying satellite images can be efficient and useful for recognition and extraction of land uses for decision making and planning. Classification of satellite images is regarded as one of the most important methods for extraction of practical information. Classification of satellite images is possible by the use of two methods. The method of "basic pixel" which is based on classification of numerical values of images and the new method of "object oriented" which in addition to numerical values, uses data related to the content, texture and background in the classification process of images [3].

The history of the research indicates that classification of images by the use of the two mentioned methods demonstrates different outcomes. In a study, the methods of basic pixel and object oriented were investigated and compared in the process of coal minerals exploration and land use maps were prepared by processing ASTER satellite images [4]. Assessing the results, he came up with the fact that the object oriented method has a higher precision in comparison with the basic pixel classification methods. In another study, using high resolution satellite images and digital aerial photographs, the green

space of Baltimore and Maryland was studied and classified using the object oriented method in the eCognition software environment [5]. The results indicate the effectiveness of the object oriented method. In a study conducted in America, using temporal satellite images and the object oriented analysis, researchers investigated the changes in Colorado's tree cover during the years 1938 to 1999. They prepared the variation trend of land use maps of each period using the object oriented method. The results showed that the region tree cover has increased 4% on average [6]. Using spot images, some researchers compared classification methods of basic pixel and object oriented in the extraction of information from satellite images. In the object oriented processing of satellite images, they used a digital elevation model and spatial information including texture and shape as a factor for increasing classification precision of the object oriented method, and having accomplished the classification by the two methods of basic pixel and object oriented, they concluded that the fuzzy classification algorithm of the object oriented method with the total accuracy of 96.42% in comparison with the maximum likelihood classification algorithm of the basic pixel classification method with a total precision of 77.79% has a higher accuracy [7]. In another study, the effect vegetation indices on the increase of the object oriented classification method were studied. They used MODIS satellite images and having extracted vegetation indices of the images and using them as a layer in the objected oriented classification, they succeeded in the increase of the object oriented classification accuracy by 5.2% [8]. Some researchers used ASTER satellite images in geology studies. In order to apply the data related to the spectral reflections and physical properties of grains of sand, they used the object oriented processing method of satellite images and insisted on the high capability of the object oriented processing in satellite images classification [9]. In Iran, using Landsat and HDR TM images of the Spot satellite, variation of the green space of the city of Tabriz was studied using the object oriented classification method [10,11]. Their study results showed that more than 46% of the green space of the city of Tabriz has been destroyed in a time period of 16 years. Using sensor HDR images of the Spot 5 satellite Lotfi et al. extracted land use maps of the city of Marand. Classification of object oriented type by the use of closest neighborhood algorithm in the eCognition basic knowledge software environment was implemented during different stages and the classification accuracy and the kia factor were respectively estimated as about 95% and 0.95 [12].
Comparing land cover/use map by the basic pixel and object oriented method and investigating parameters affecting images classification, the present study assesses the increase in precision and how segmentation parameters are effective. For this purpose, the land use map of the city of Malayer (as one of the most important poles of gardening and grape industry of the country) was prepared and the results were compared using the basic pixel and object oriented methods and satellite images.

MATERIAL AND METHODS

The area under study in this research is the city of Malayer, one of the affiliated cities of Hamedan province. The city is located in the 34°,26°° north latitude and 48°,50°° east longitude of prime meridian. The city of Malayer, with an area equal to 3326 km^2 covers a span of more than 16.9% of the total province area (figure 1).

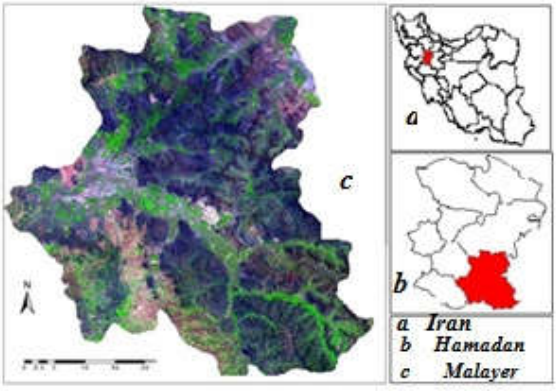

Figure 1: Malayer City in West of Iran

The data that are used include Landsat 8 satellite image with the pass number 166 and row number 33 in 14 May 2013, topographical map of the region with a scale of 1/50000, land use map of the city of Malayer, the data obtained from GPS during field operations in Malayer land and the data obtained from Google Earth. Generally, various types of software were used in different stages of doing the research. The software used includes ENVI5, eCognition Developer, Arc GIS 10.1 and Google Earth.

The purpose of this study is to compare the classification algorithm of the maximum likelihood in the based pixel processing method with the closest neighbor algorithm in the object oriented processing for evaluation of classification performance of Landsat 8 satellite images. However, given that classification is just one of the stages of image processing, the necessary actions were performed on the images in the pre-processing stage. Of these stages are making satellite images as reference earth using 1/25000 maps and atmospheric modifications based on deduction of numerical value of dark pixels and description of each stage is as follows:

A- Geometric correction

In the first stage of ArcGIS10.1 software, 1/50000 topographic maps of the studied area (7 sheets), each sheet with six scattered point across the map, became the reference earth using affine first order equation which is a linear function and their value of root mean square error was obtained as 0.006. Due to estimation of four main components of their position, points scale, extension and rotation, the use of affine equation in spatial correction has a more desirable effectiveness [13]. In the next step, in order to perform geometric correction whose most common non-parametric method is the use of ground control points [14], control points on the image with appropriate transmittance of the studied region area were collected and implemented on the image surface in the environment of ENVI 4.7 software. Then, the closest neighbor method was used to sample the value of pixels again. In this regard, 13 control points were specified which were mostly in the intersection of roads and waterways and were scattered across the image and topographic maps and the geometrical correction was implemented on the image using resampling and the closest neighbor method.

The calculated RMS value was 0.65 pixels.

B- Radiometric correction

Radiometric corrections include those modifications that are only implemented on grey steps and we can try to compensate some errors only by changing their values independently (pixel by pixel). Of these errors are atmospheric errors, striped disruption, missing lines and machine errors [12]. Some of the errors like missing lines must certainly be corrected while some common errors with no significant effect on the classification result (like some atmospheric errors) or with very low and insignificant value can be ignored. On atmospheric corrections, if single temporal images are used in the classification, there may be no need to make modification [15]. Since a single temporal image was used in this study and the image is related to 14 May (28th Ordibehesht) and also the desired area is relatively uniform from weather perspective and the sky was clear with no clouds, there is no need to perform atmospheric modifications and they were ignored.

C- Object oriented classification of satellite images

Classification is a decision making process where imagery data are carried to the space of specific classes [16]. Satellite images classification has some limitation based on spectral information. Therefore, other sources of information should be used to increase the classification accuracy [7]. Therefore the necessity of using object oriented classification by eCognition software is that in addition to spectral information, the data related to texture, shape and relations between phenomena (which are called interrogative information) are used in classification of images. Therefore the object oriented classification is a process that connects land cover classes to imagery objects and each of imagery objects is assigned to the considered classes with a definite membership degree [17]. The algorithm used for classification in the object oriented method is the closest neighbor one. In the classification process by the algorithm, pixels are assigned to various classes based on their weights. Therefore, in the classification method, the mixed pixel has a membership degree for each class and is classified in a special class based on fuzzy logic and proportionate with the highest membership degree [11]. The conditions suitable for classification of classes in this study are defined for classes as follows:

- definition of shape and ratio of length to width as an effective factor on the isolation of riverbed
- definition of the shape factor as an effective factor on the isolation of agriculturally fallowed land from arid land class
- definition of texture factor as an effective factor on the isolation of classes
- the use of the closest neighbor algorithm in the object oriented classification for all classes
- the use of sigmoid, J form and linear functions in the definition of classification conditions for classes

D- Segmentation

Basic processing units of object oriented analyses are imagery objects (segments) not pixels [18]. Segment means a group of neighboring pixels in an area that similarity (like numerical value and texture) is their most important common criterion. In this process, segments fragment and separate areas of the image surface with specific and uniform shape, texture and scale as neighboring regions. The size of

segments is determined based on parameters such as scale, color, shape, image softness modulus and compression factor and these parameters are selected based on the level and goal of the study and the interpreter's opinion. In this study, given that orbit 7 sample method was used for classification, parameters of scale and color uniformity was used for segmentation. The first stage in the object oriented classification process is segmentation. The results indicated that choosing parameters of scale 5, color homogeneity of 0.65 for separation and diagnosis of image objects at level one in classification process will have acceptable result.

E- Classification

In the object oriented classification, the main unit of image processing is the shape of objects or segments. In this image method, proportionate with the interpreter's opinion based on determination of specific parameters for segments in the form of separated imagery objects and specific parts, the image is classified. In this study, considering appropriate parameters such as scale and color in the segmentation stage, the classification process was accomplished. The results showed that the desired applications in the classification are distinct and separable.

F- Educational sample objects

The object oriented classification, like supervised classification, needs educational samples too. In eCognition software, the range of educational samples is specified in the image surface using sample objects which suggest the existing complications in the desired area. The use of the closest neighbor algorithm for classification by the object oriented method needs less educational samples than the basic pixel method.

G- The best classification result

In the eCognition software, the imagery objects get the membership degree for each class as class hierarchy. As long as the highest membership degree is not created for each of the image objects, the result of classification can be corrected by changing equations for classification and attain the highest membership degree. Using the closest neighbor classification, the highest membership degree shows the closest distance from a definite sample. For each of imagery objects, the increase of the slope of the closest neighbor function can lead to the increase of the best classification result.

H- Samples classification error matrix

Using the error matrix based on the introduced samples for various application, eCognition software presents the evaluation of accuracy and precision. Thus, the software automatically forms the error matrix and calculates Kappa factor (table 2). Overall accuracy based on the registered samples was obtained as 0.88 for applications and Kappa factor was also obtained as 0.85.

I-Supervised classification by the maximum likelihood method

In the basic pixel processing method, pixel is considered as the main unit and numerical values of images are regarded as the basis for classification. This method of classification is conducted based on statistical methods as supervised and unsupervised, where a single pixel is only put in one class. The classical view is based on binary theory. Based on this theory, a pixel is put in one of the classes or is not assessed to be put in one of the classes and is remained unclassified. Based on binary theory, pixels are classified in one class in the overlapping range of duties, while the pixels have correlation with other classes and the correlation is one of the important factors of reduction of accuracy of the basic pixel classification [3, 4]. In the classification, spectral signatures are used to rank pixels, such that classification in the form of considered classes is done by determination of specific pixels of the image. For this purpose, using the software ENVI 4.7, fifteen spectral signatures, as pure and scattered pixels across the image, were introduced to the software for each class. Then, given the observation of the spectral curve and their histogram, samples of each class were combined with each other and were considered as the final class (class spectral signatures related to man-made regions were extracted as mixed up pixels because they are a combination of various phenomena and their spectral reflection is different). Therefore, in this step, having extracted appropriate spectral signatures, the supervised classification was performed by the maximum likelihood method and the land use map was extracted for seven classes of water, irrigated agriculture, grassland, dry farm land, saline lands, man-made regions class and mountainous areas for the image (figure 3).

Saline land is one of the difficulties of land breakdown because the lands have various applications such as dry farming and pasture and also due to the fact that they are very similar to mountainous regions from spectral reflection perspective. In rural areas with low extent, the two applications interfere with each other and are selected as saline land. However the action doesn't come to sight in urban residential areas. For this reason, one of the error causes in estimation of accuracy and precision of classification is saline land.

J- Educational (training) samples

In order to perform the supervised classification, given recognition of the studied region (after the field visit) and the ground samplings (using GPS) and also numerous samplings using Google Earth and the results obtained from unsupervised classification, determination of educational (training) samples was performed randomly and systematically for various classes of the desired land use. For this purpose, firstly the studied area was carried to Google Earth and a network of 5*5 km was created. In the intersection of each network the ground fact point was registered. Thus, a number of 1070 samples of the existing applications were picked up in the area, which was used for assessment of accuracy and precision of classification in the next stages (table 3).

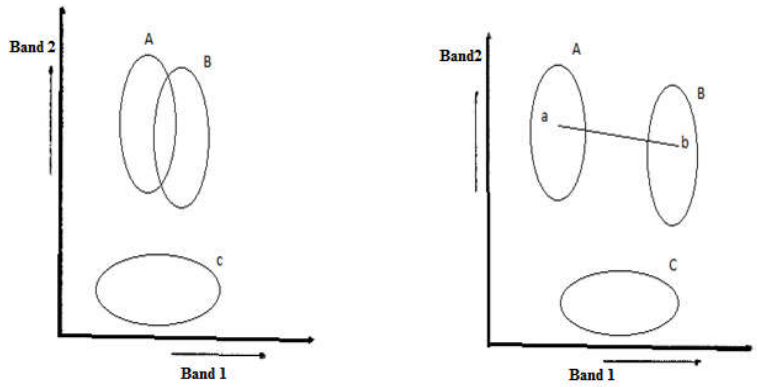

Figure 2: Comparison of classification of classes with the same spectral patterns (a) and the space of overlapping effects or mixed pixels (b)

Pixels related to the overlapping space (for example the space between classes A and B in figure 2 (b)) have information that is common with the information of other classes. In most cases, pixels of this type are known as mixed pixels and are not put correctly in one of the grades of land cover classes. The factor causes the pixels situated in the overlapped regions not to be classified correctly and classification accuracy to reduce [19]. In the present study, for the basic pixel classification of Landsat 8 satellite images, the educational samples picked up for each class (table 4) were implemented on the image surface. Then, calculating the resolution of the classes and making sure of appropriate resolution for each class, having analyzed the statistical specifications of classes and educational samples and evaluating the spectral reflection curves of each class, which were drawn based on picked up educational samples for each class, the band composition 3-4-5 was selected as the best band combination for the classification. Classes had a completely suitable resolution except for saline land class that has errors due to having a spectral reflection similar to the residential area and is negligible because this happens in very small sized residential regions.

K- Evaluation of accuracy and precision

None of the various classification methods are complete. Therefore their accuracy and precision is evaluated [19]. Evaluation of accuracy and precision of classification is an important and general issue for the comparison of classification result with the ground reality [20]. In this study, evaluation of accuracy and precision was estimated based on the two results of the best classification and the samples classification error matrix. Having implemented the educational samples on the image surface and forming the error matrix, the overall precision of the classification with the maximum likelihood algorithm and Kappa factor were respectively obtained as 75% and 0.67. Table 5 shows the error value and applications precision. According to the obtained results in the table, the class related to water and application of regions with rock cover (mountainous) have respectively had the highest and lowest error values of 100% and 50%.

RESULTS

This section consists of presentation of the research results and the related issues. Evaluation of various land uses of the city of Malayer using the results of the best classification, the classification error matrix, number of educational samples for each of the land use classes, number of educational samples picked up for each of the land use classes and evaluation of accuracy and precision of various land classes have respectively been presented in tables 1, 2, 3, 4 and 5.

Table 1: Evaluation by the use of the best classification results

class	object	mean	standard deviation	minimum	maximum
water	59	0.94	0.13	0.6	1
saline lands	7108	0.97	0.03	0.53	1
man-made areas	1026	0.95	0.07	0.2	0.99
dry farms	14813	0.98	0.01	0.61	0.99
pasture	4152	0.98	0.01	0.89	1
mountainous regions	16989	0.98	0.01	0.74	1
irrigated agriculture	6090	0.96	0.05	0.39	0.99

Table 2: Classification error matrix of various land uses

samples	producer precision	user precision
water	1	1
saline lands	0.92	0.96
man-made areas	0.94	0.95
dry farms	0.93	0.93
pasture	0.91	0.77
mountainous regions	0.85	0.83
irrigated agriculture	0.91	0.91

Table 3: The number of educational samples for each of the land use classes

lands use	number of educational samples for each class
pasture	305
dry farms	270
water (watery areas)	55
irrigated agriculture	95
mountainous regions	160
saline lands	155
man-made areas	30
total sum of picked up points	1070

Table 4: Number of picked up educational samples for each of land use classes

class	number of samples
water (watery regions)	20
mountainous regions	45
saline lands	55
residential regions	33
irrigated agriculture	42
pasture	27
dry farms	37

Table 5: Evaluation of accuracy and precision of various land classes

class	producer precision	user precision
water (watery regions)	100	100
mountainous regions	50.00	21.88
saline lands	90.00	58.06
residential regions	58.71	100
irrigated agriculture	44.19	100
pasture	73.77	73.77
dry farms	67.24	72.22

The performed classification process is reversible and continues until the highest membership degree for each class is achieved. In this study, having selected the educational sample objects for the specified classes, the object oriented classification is performed, whose obtained results are shown in figures 3 and 4.

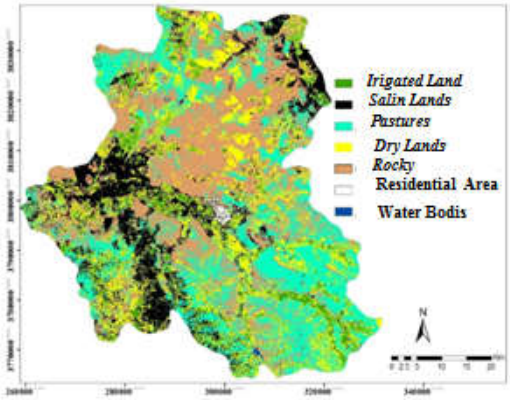

Figure 3: The use map extracted by the maximum likelihood algorithm in the basic pixel classification method

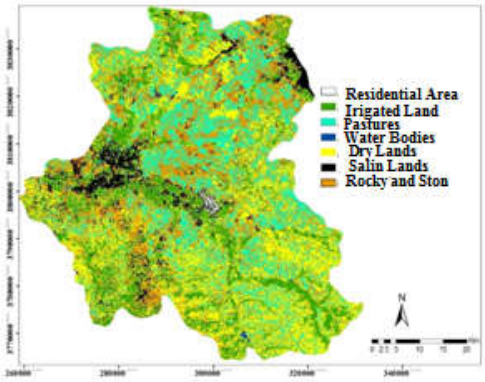

Figure 4: The use map extracted by the closest neighbor algorithm in the basic object classification method

The results show that the closest neighbor algorithm of the object oriented method makes it possible to achieve higher precision than the maximum likelihood algorithm of the basic pixel method in the digital satellite images classification. One of the most important reasons for achieving the higher precision in the classification method by the closest neighbor algorithm is that in addition to the spectral information, the data related to texture, shape, situation and content are also used in the classification process of the method. Therefore the classification precision enhances increasingly. In the classification with the maximum likelihood basic pixel algorithm, pixels situated on the separator line of classes should ultimately assigned to one of classes of water, soil or plant (hard classification), but in the object oriented classification, pixels are assigned to various classes according to their weights (soft classification). In this method of classification, mixed pixels have a membership degree for each class and are classified in a special class based on fuzzy logic and proportionate with the highest membership degree.

Having classified by the two methods of basic pixel and object oriented, the parameters of accuracy evaluation of both methods were computed and presented in table (6).

Table 6: Comparison of basic pixel and object oriented classification methods in the city of Malayer

classification method	classification algorithm	overall accuracy of classification in percent	Kappa factor of classification
basic pixel	maximum likelihood	72	0.67
object oriented	closest neighbor	88	0.85

Thus, the results indicate that the object oriented classification method with the overall accuracy of 88% versus the overall accuracy of 72% for the basic pixel classification of satellite images has a higher precision.

CONCLUSION

In this study, the basic pixel and object oriented methods of land classification using Landsat 8 satellite images were compared in Malayer city in west of Iran. The results indicate that segmentation quality and determination of segments scales have a direct relationship with the spatial resolution of satellite images. In order to compare the results, the most important accuracy evaluation methods including the overall

precision and Kappa factor of the classification were computed. The closest neighbor algorithm of the object oriented classification method results in a higher precision of about 16% (for both indices of overall precision and Kappa factor) than the maximum likelihood algorithm of the basic pixel in the classification of images. The important issue has also been approved in other researchers' studies which were mentioned in the research background. Achieving the overall precision of 88% by the objected oriented classification against 72% by the basic pixel classification shows that the closest neighbor algorithm of the object oriented method makes it possible to achieve higher precision than the maximum likelihood algorithm of the basic pixel method in the digital satellite images classification.

REFERENCES

1. Innocent E. & Joel I. (2013). Mapping and Analysis of Land Use and Land Cover for a Sustainable Development Using High Resolution Satellite Images and GIS, Conference: FIG Working Week 2013, Environment for Sustainability; Abuja, Nigeria, 6 – 10 May 2013., At Abuja, Nigeria, Volume: FIG2013.
2. Assefa, b. (2010). Analysis of Impact of Resettlement on Land Use and Land Cover Dynamics and Change Modeling: The Case of Selected Resettlement Kebeles in Gimbo Woreda,Kafa Zone, A Thesis Submitted to the School of Graduate Studies of Addis Ababa University for the Degree of Master of Science in Environmental Science, pp. 5-18.
3. Feizizadeh, B. & Haj Mir Rahimi, M. (1996). Detection of variations of the green space of the city of Tabriz using the object oriented methods, Urban GIS conference, in Persian.
4. Yan, G. (2003). Pixel based and object oriented image analysis for coal fire research. Master Thesis, ITC, Netherlands.
5. Zhou W., Austin T., Morgan G. (2005). Measuring Urban arcel Lawn Greenness by Using an Object-oriented Classification Approach, Rubenstein School of Environment and Natural Resources, University of Vermont, George D. Aiken Center, 81 Carrigan Drive.
6. Platt, R. V. & Schoennagel, T. (2009). an object-oriented approach to assessing changes in tree cover in the Colorado Front Range 1938–1999, Forest Ecology and Management 258 (2009) Pages 1342–1349.
7. Chen, M, Su.W, Li.L, Chao.Z, Yue.A & Li.H. (2009). Pixled_based and Object-oriented Knowledge- based Classification Methods Using SPOT5 Imagery, Wseas Transactions On Information Science And Applications, ISSN: 17900832, pp477-489.
8. Gao, Y, mas.J.F and Naverete.A. (2009). The improvement of an object-oriented classification using multi temporal MODIS EVI satellite data, International Journal of digital Earth, Volume 2, Issue 3 September 2009, pp. 219 – 236
9. Zhaocong, W, Lina, Y. and Maoyun, Q. (2009). Granular Approach to Object-Oriented Remote sensing Image classification, RSKT 2009, LNCS5589, 2009. Springer-Verlag Berlin Heidelberg 2009, pp. 563570.
10. Rezaei Moghaddam, M., Rezaei Banafsheh, M., Feizizadeh, B., Nazmfar, H., (1999). Classification of lands cover/use based on the object oriented technique and satellite images, case study: West Azerbaijan province, watershed studies, No. 87.
11. Feizizadeh, B., Halali, H. (1998). Comparison of basic pixel and object oriented methods and the parameters affecting classification of land use/cover of West Azerbaijan province, natural geography studies, No. 71, Spring 1388, pp. 73-84.
12. Fatemi, B., Rezaei, Y. (1999). Remote sensing principles, second edition, pp. 175-230.
13. Ahani, H., Ghorbani, A., Rastegar Moghaddam, M., Fallah Shamsi, R., Baghernejad, Majid, (1388). Evaluation of land use variations using satellite images; case study: watershed basin of Tangsorkh Shiraz.
14. Jahedi, F & Farrokhi, S.(1995). Remote sensing principles (Translation), Iran's remote sensing center, p. 329.
15. Song, C., Woodcock, C.E., Seto, K.C., Lenney, M.P. and MA Comber, S.A., (2001), Classification and change detection using Landsat TM data: when and how to correct atmospheric effect. Remote Sensing of Environment, 75, pp. 230–244.
16. Fatemi, M. (2001). A guided Study to Model-Based Image Analysis", Study Report, K.N. Turky.
17. Lewinski, S and Zarenski, K., 2004. Examples 0f Object-Oriented classification .performed on high-resolution satellite images.
18. Jyothi B. N, Babu G.R. and Murali Krishna I.V. (2008). Object Oriented and Multi-Scale Image Analysis: Strengths, Weaknesses, Opportunities and Threats-A Review, Journal of Computer Science 4 (9): 706- 712.
19. Lillesand, T. Kiefer R. & Chipman, J. (2004). Remote sensing and image interpretation. 5th Edn. John Wiley and Sons, Inc. USA.
20. Matinfar. H. R, Sarmadian. F., Alavi Panah. S. and Hech .R. (2007). Comparisons of Object-Oriented and Pixel-Based Classification of Land Use/Land Cover Types Based on Lansadsat7, Etm+ Spectral Bands (Case Study: Arid Region of Iran), American-Eurasian J. Agric. & Environ. Sci., 2 (4): 448-456, 2007, ISSN 1818-6769, © IDOSI Publications..