



Evaluation of pixel-based and object-oriented classification methods in preparing land cover maps using Landsat satellite images in Idrisi Terrset software (Case study: Doviraj region of Ilam Province)

Saleh Arekhi*¹

1. Associate Professor, Department of Geography and GIS, Faculty of Human Sciences, Golestan University, Gorgan, Iran

Received Date: 09 March 2025 Accepted Date: 15 September 2025

Abstract

Background and Objective: In recent years, the preparation of land cover maps through digital classification of remote sensing data has been considered as a suitable alternative for the preparation of this type of maps. Remote sensing is one of the new and efficient technologies in extracting land cover, updating maps, and detecting land cover changes. In this direction, the aim of present study is to compare two methods of pixel-based and object-oriented classification in land cover mapping with using OLI image in Doviraj region, Ilam province using Idrisi Teerrset software.

Research Method: After the supply of related image and implementing geometric and radiometric corrections on image, we applied two classification methods to land cover mapping. To assess the accuracy of classification methods, we used of indices of overall accuracy, kappa coefficient, producer accuracy and user accuracy. The results show that the object-oriented classification method has more resolution than the pixel-based classification method.

Findings and Conclusion: The results of accuracy show that method of object-oriented in two indices of overall accuracy and kappa coefficient with (respectively) 94 percent and 0/93 percent was more accuracy then to pixel-based classification method with overall and Kappa coefficient 88 percent and 0/87 percent. The result of this study suggests that from object-oriented classification method use to production of land ucover map.

Keywords: Land cover, Pixel-based Classification, Object-oriented Classification, OLI, Doviraj region, Idrisi Terrset, Ilam Province.

* Corresponding Author Email: s.arekhi@gu.ac.ir

Cite this article: Arekhi, S. (2026). Evaluation of pixel-based and object-oriented classification methods in preparing land cover maps using Landsat satellite images in Idrisi Terrset software (Case study: Doviraj region of Ilam Province). Journal of Sustainable Urban & Regional Development Studies (JSURDS), 7(1), 209-223.

Extended Abstract

Introduction:

Land use includes various types of land use to meet various human needs. Land cover maps are a realistic representation of biological and physical phenomena on the earth's surface, such as vegetation, water, desert, ice, snow, and man-made phenomena. Basically, for optimal use of natural resource capabilities, obtaining accurate information on land use and land cover potentials is essential. Today, remote sensing technology is scientifically cited as a valuable solution for identifying natural resources, especially in the process of preparing vegetation and land use maps, in different regions of the world. Mapping vegetation and land use changes provides valuable information for understanding the state of nature and the anthropogenic environment by quantifying vegetation at local to global scales over a specific time period or over a continuous time period. Also, detecting vegetation changes is an indicator for determining landscape heterogeneity and biodiversity and ultimately determining priority areas for conservation. Traditional methods for investigating vegetation/land use, such as terrestrial mapping, are generally time-consuming and expensive. Meanwhile, satellite data, due to its superior features such as wide coverage, repeatability, and continuous updating, can be considered as the first choice in the discussion of land use recognition and preparation. The up-to- dateness and accuracy of these maps can play a significant role in the management and planning of natural and urban lands. The main goal of processing satellite images is to prepare thematic and efficient maps, and choosing an appropriate classification method plays an important role in this. Many classification methods, including maximum likelihood, minimum distance, etc., use spectral information in image bands. In these methods, it is expected that pixels with higher or lower brightness levels will be grouped in a multi-spectral space and in clusters appropriate to the types of land cover. Based on the research conducted, these methods have limited ability to separate classes that have similar spectral information and merge. As a result, in recent years, with the advancement of computer processing technology, new methods have been proposed for classifying high and medium resolution images. For example, the use of neural network methods, decision tree methods, methods derived from fuzzy logic theory, and the use of secondary information such as texture, background, and terrain features are among the most important of these methods. Based on the characteristics of image processing, in order to extract information from satellite images in these methods, they can be divided into two main groups, which are: a) classification method based on numerical values of image elements or pixels (base pixel) and b) classification method based on image objects (object-oriented).

Methodology

After preparing the satellite image using ground control points, the image was referenced to the ground with an error of about 0.4. Also, the relative radiometric correction method was used for radiometric correction. This method is to reduce the effects of atmospheric scattering on the image. After preparing the image, using the training samples collected (70% for classification and 30% for evaluation) from each user, the image was classified using the maximum likelihood method. Then, to perform the object-oriented method, homogeneous image segments were first created. The Idrisi TerrSet software divides the image into homogeneous segments based on four factors: window width, similarity tolerance, weighted average, and weighted variance factor, and the best value of these factors is obtained by trial and error. In the next step, based on the segmented image, and based on the training sample selected from them, the image is classified using one of the pixel-based classification methods, which usually uses the minimum distance from the mean method. In the last step, the software classifies the image using the object-oriented method based on the segmented image and the pixel-based classification. The most important factor affecting image

segmentation is the similarity tolerance. The closer this index is to 100, the smaller the final size of the segments becomes. This process will be repeated until the best result is obtained based on the user's opinion.

Results and Discussion

After classifying the image using pixel-based and object-oriented methods, then, the accuracy of the classifications was evaluated. To do this, training samples for each class were randomly collected from the study area. After implementing the training samples on the image level, the two classification methods were finally evaluated for accuracy. An examination of the producer and user accuracy for each of the methods used showed that in the pixel-based method, the most important factor reducing the producer accuracy for poor rangeland use and the user accuracy for fair rangeland use was spectral similarity. In addition, the same is true for the object-oriented method. However, object-oriented classification, due to the use of segmented background, has distinguished and classified these two applications much better than the pixel-based method. After classification by the two methods, a land use map of the Doiraj region was produced. Then, for each of the methods used, the area of different land uses was calculated and compared with each other. Based on the results obtained, the fair rangeland land use was the most extensive land use in both methods. A comparison of the areas of land uses extracted by the two methods shows that the largest difference was related to the fair rangeland land use (1251.72 hectares) and the smallest difference was related to the good rangeland land use (139.32 hectares). In the maximum likelihood method, the variance and covariance of the data are evaluated and it is assumed that all training areas have the same distribution. In fact, the training samples should be representative of all classes. Therefore, the more training samples are used, the more changes in the spectral features will be in that range. In contrast, object-oriented classification is a method based on segmentation. Image segmentation is the process of integrating pixels based on the homogeneity of image phenomena and is controlled based on four factors: window width, similarity tolerance, weighted average and weighted variance factor. The segments must be homogeneous within themselves and represent only one class, not a combination of several classes, and at the same time, there must be heterogeneity and differences between adjacent phenomena in the entire image. Creating a hierarchical network of segmentation is possible using a scale index, in which different levels of segments are created. In this hierarchy, smaller segments are always embedded in higher-level segments. Segmentation is possible using a scale index, in which different levels of segments are created. The main difference between the two methods of pixel-based classification and object-oriented classification is that the first method leads to a local result due to the marking of pixels or areas that have met the introduced criteria, while in the second method the entire image is converted into separate units. In fact, this method classifies image pixels into groups that meet uniformity criteria. Therefore, the object-oriented method first performs a complete image segmentation to identify the basic classification units. The accuracy assessment of the generated land uses showed that in both pixel-based and object-oriented methods, poor and fair rangeland were the most important factor in reducing accuracy. The reason for this reduction in accuracy is the spectral overlap and relative similarity in the pattern of land uses including poor and fair rangeland. Also state that the similarity in the spectral patterns of poor and medium rangeland was the factor in reducing the accuracy of the final maps produced. The scattered and small size of poor and medium rangeland within the region has caused difficulties in identifying and separating these two uses in pixel-based and object-oriented classification. Object-oriented classification, due to the use of segmented background, has separated and classified these two uses much better than the pixel-based method.

Conclusion

The results of this study indicate the high efficiency and reliability of the object-oriented method in extracting land cover maps. However, the limitation in selecting optimal segmentation parameters and the potential error in segmentation are considered problems and disadvantages of segmentation and, in a way, object-oriented methods. Errors in segmentation can cause errors (deletion or addition) in classification. This will pose a serious challenge to the use of this method. Finally, considering the results obtained from this study and other work done, it can be stated that the object-oriented classification method is a suitable and more accurate method for extracting land use maps and also studying land cover changes compared to pixel-based methods if the segmentation process is carried out correctly.

Declarations

Funding

There is no funding support for this study.

Authors' Contribution

Authors contributed equally to the conceptualization and writing of the article. All of the authors approved the content of the manuscript and agreed on all aspects of the work declaration of competing interest none.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgments

We are grateful to all the scientific consultants of this paper.

References

- Ilam Province Management and Planning Organization (2006). "The Position of Ilam Province in Realizing Land Planning Orientations". Ilam Statistical Yearbook (Population) (In Persian).
<https://amar.org.ir/salnameh-amari/agentType/ViewType/PropertyTypeID/621>
- Najafi, A. (2010). "Geomorphological Capabilities and Limitations of Physical Development of Ilam City," Master's Thesis in Geomorphology, University of Tehran, 192 (In Persian).
https://gisj.sbu.ac.ir/article_95148_9a7399f4431ed9b2867447a440706f86.pdf?lang=en
- Abedini, M., Pasban, A., & nezafat taklhe, B. (2023). Evaluation and Preparation of Land Use Map of Nirchai Watershed Using Object Oriented Method. *Geography and Human Relationships*, 5(4), 318-328. [In Persian]
<https://doi.org/10.22034/gahr.2023.393602.1849>
- Abiyat, M., Attar Roshan, S., & Abiyat, M. (2020). Evaluating and Predicting Vegetation Changes Pertaining to Land Use Changes using LCM Model and CA-Markov Chain (Case Study: Ahvaz City). *Journal of Geography and Environmental Hazards*, 9(3), 183-204. [In Persian]
<https://doi.org/10.22067/geoh.2020.67236.0>
- Alavipanah, S.K. (2003). Application Remote Sensing in Geology (Earth Sciences), Tehran University Press, 478 pages.

- Alimohamadi, A., Motakan, A.A., Zeiaeian, P., Tabatabaei, H. (2009). Comparison of pixel-based classification methods, object-oriented and decision trees forest type mapping using remote sensing data (Case study: forest Astara), *Journal of Geographical Sciences and Applied Research*, Vol 10(13), Summer, 20 pages.
- Baatz, M., Schape, A. (1999). Object-oriented and Multi Scale Image Analysis in Semantic Networks, *Proceeding of the 2nd international symposium on remote sensing*, 16-22 August, Ensched, ITC.
- <https://www.semanticscholar.org/paper/Object-oriented-and-Multi-scale-Image-Analysis-in-Baatz-Sch%3%A4pe/78ca6f50f56a85efa6e738815727504a1bc8f2b9>
- Baatz, M., Ursula, B., Seyed, D., Markus, H., Astrid, H., Peter, H., Iris, L., Matthias, M., Malte, S., Michaela, W., Gregor, W. (2004). *eCognition User Guide*, Definiens Imaging GmbH, München Germany.
- <https://www.yumpu.com/en/document/view/21501603/ecognition4-professional-user-guide-unbc-gis-lab>
- Bandari, A.K, Kummar, A., Singh, G.K., 2012. Feature extraction using normalized difference vegetation index (NDVI), a case study of Jabalpur city. *Procedia Technogy* 6, 612 - 621.
- <https://doi.org/10.1016/j.protcy.2012.10.074>
- Boniad, A.E., Hajighaderi, T. (2008). Mapping of Natural Forest Stands of Zanjan Province Using Landsat 7ETM⁺ sensor data, *Science and Technology of Agriculture and Natural Resources*, 42(11): 627-638.
- <https://jstnar.iut.ac.ir/article-1-814-en.pdf>
- Borri, D., Caprioli, M., Tarantino, E. (2005). Spatial Information Extraction from VHR Satellite Data to Detect Land Cover Transformations, Polytechnic University of Bari, Italy, pp.105.
- https://www.sepehr.org/article_15552_d2ba13bb61e366a9f48cb84b60f7f814.pdf?lang=en
- Chavez, P.S. (1996). Image-based atmospheric corrections-Revisited and improved. *Photogrammetric Engineering and Remote Sensing*, 62: 1025- 1036.
- https://www.asprs.org/wp-content/uploads/pers/1996journal/sep/1996_sep_1025-1036.pdf
- Chavez, P.S.J.R., Mackinnon, D.J. (1994). "Automatic detection of vegetation changes in the southwestern United States using remotely sensed images", *Photogrammetric Engineering and Remote Sensing*, 60: 571–583.
- <https://www.cabidigitallibrary.org/doi/full/10.5555/19960600166>
- Chen, M., Su, W., Li, L., Chao, Z., Yue, A., Li, H. (2009). Pixel-based and Object-oriented Knowledgebased Classification Methods Using SPOT5 Imagery, *WSEAS TRANSACTIONS on INFORMATION SCIENCE and APPLICATIONS*, ISSN: 1790-0832, pages 477-489.
- Coppin, P., Jonckheere, I., Nackaerts, K., Muys, B., Lambin, E. (2004). Digital change detection methods in ecosystem monitoring: A review. *International Journal of Remote Sensing*, 10: 1565-1596.
- <https://doi.org/10.1080/0143116031000101675>
- Definiens Imaging GmbH. (2006). *Definiens Professional5 User Guide*, <http://www.definiens.com/.Userguide.pdf>, 249 pp.
- Dehviri, A., Heck, R.J. (2009). Comparison of object-based and pixel based infrared airborne image classification methods using DEM thematic layer, *Journal of Geography and Regional Planning*, 2(4): 086-096.
- <https://www.internationalscholarsjournals.com/articles/comparison-of-objectbased-and-pixel-based-infrared-airborne-image-classification-methods-using-dem-thematic-layer.pdf>

- Du, Y., Teillet, P.M., Cihlar, J. (2002). "Radiometric normalization of multitemporal high-resolution satellite images with quality control for land cover change detection", *Remote Sensing of Environment*, 82: 123–134.
[https://doi.org/10.1016/S0034-4257\(02\)00029-9](https://doi.org/10.1016/S0034-4257(02)00029-9)
- Fazizadeh, B. (2007). Comparison of pixel-based and object-oriented methods in land use mapping Master's thesis, GIS Center Tabriz University.
- Fazizadeh, B., Azizi, H., Valizadeh, KH. (2007). land use Mining of Malekan city using Landsat 7 ETM+ satellite imagery, *Spatial Planning Magazine*, Issue 3, Branch Malayer.
<https://sanad.iau.ir/en/Journal/ebtp/Article/988289>
- Fazizadeh, B., Helali, H. (2010). Comparison of pixel-based and object-oriented and parameters affecting the on land use/cover of West Azerbaijan province, *Geography Studies*, No. 71, 73-84.
<https://www.sid.ir/paper/138891/en#downloadbottom>
- Gao, Y., Mas, J.F., Navarrete, 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.
<https://doi.org/10.1080/17538940902818311>
- Geneletti, D., Gorte, B.G.H. (2003). A method for Object-oriented land cover classification combining Tm data and aerial photographs, *International Journal of Remote sensing*, vol, 24, no.6, 1237-1286.
<https://doi.org/10.1080/01431160210144499>
- Ghafari, S., Moradi, H.R., & Modarres, R. (2018). Comparison of Object-Oriented and Pixel-Based Classification Methods for Land Use Mapping (Case Study: Isfahan-Borkhar, Najafabad and Chadegan Plains). *Journal of Remote sensing and Geographical information system for natural Resources*, 9(1), 40-57. [In Persian]
https://journals.iau.ir/article_540415.html
- Gorte, B. (1998). Probabilistic Segmentation of remotely sensed images, ITC Publication63, Ph.D. Thesis, Ensched, ITC.
https://ris.utwente.nl/ws/portalfiles/portal/353638521/thesis_B_Gorte.pdf
- Hussaina, M., Chen, D., Cheng, A., Wei, H., Stenley, D. (2013). Change detection from remotely sensed images: From pixel-based to object-based approaches, *ISPRS Journal of Photogrammetry and Remote Sensing* 80: 91–106.
<https://doi.org/10.1016/j.isprsjprs.2013.03.006>
- Igué, A.M., Houndagba C.J., Gaiser, T., & Stahr, K., (2022). Accuracy of the Land Use/Cover Classification in the Oueme Basin of Benin (West Africa). *International Journal of AgriScience*, 2(2), 174-184.
<https://www.cabidigitallibrary.org/doi/pdf/10.5555/20123239823>
- Karami, A., Khorani, A.A., Falahshamsi, S.R., Mosavi, V., Khosravi, G.H. (2012). Object-oriented application of remote sensing to map gully erosion, 20th Conference of Geomatics of Iran, 8 p.
- Kerr, J.T., Ostrovsky, M., 2003. From space to Species: ecological application for remote sensing. *Trend in Ecology and Evolution* 18(6), 299-305.
[https://doi.org/10.1016/S0169-5347\(03\)00071-5](https://doi.org/10.1016/S0169-5347(03)00071-5)
- Khosravi, I., Momeni, M. (2012). Identification structure of high-resolution satellite imagery using object-based image analysis, 20th Conference of Geomatics of Iran, 10 p.
- Li, M., Ma, L., Blaschke, T., Cheng, L. & Tiede, D. (2016). A systematic comparison of different object-based classification techniques using high spatial resolution imagery in agricultural environments. *International Journal of Applied Earth Observation and Geoinformation*, 49, 87-98.

<https://doi.org/10.1016/j.jag.2016.01.011>

Lu, D., Mausel, P., Brondi'zio, E., Moran, E. (2004). Change detection techniques. INT. J. REMOTE SENSING, 20 JUNE, 2004, VOL. 25, NO. 12, 2365–2407.

<https://doi.org/10.1080/0143116031000139863>

Mackie, R.I. (2013). Dynamic analysis of structures on multicore computers – Achieving efficiency through object oriented design, *Advances in Engineering Software* 66: 3–9.

DOI: [10.1016/j.advengsoft.2013.03.006](https://doi.org/10.1016/j.advengsoft.2013.03.006)

Matinfar, H.R., Sarmadian, F., Alavipanah, S.K., Heck, R. (2008). Characterizing Land use/land cover types by Landsat7data based upon Object oriented approach in Kashan region, *Iranian journal of Range and Desert Research*, 14 (4): 589-602.

https://ijrdr.areeo.ac.ir/article_105769_8d5cba654a774f0100e21baf0371777.pdf?lang=en

Mori, M., Hirose, Y., Akamatsu, Y.L. (2003). Object- based classification of Ikonos data for rural land use mapping. *Http://www.define.com. eCognition Applied Notes* , Vol 5 , No. 1.

<https://www.isprs.org/proceedings/xxxv/congress/comm3/papers/305.pdf>

Petropoulos, G.P., Kalaitzidis, C., Vadrevu, K.P. (2012). Support vector machines and object-based classification for obtaining land-use/cover cartography from Hyperion hyperspectral imagery, *Computers & Geosciences*, 41: 99–107.

<https://doi.org/10.1016/j.cageo.2011.08.019>

Piri, A. (2011). The Vision of Natural Resources and Watershed Management of Ilam Province, *Institution of forests and rangeland researches*, 56p.

<https://4.rifr-ac.ir/departement-of-rangeland-research/>

Puissant, A., Rougier, S., Stumpf, A. (2014). Object-oriented mapping of urban trees using Random Forest classifiers, *International Journal of Applied Earth Observation and Geoinformation*, 26: 235–245.

<https://doi.org/10.1016/j.jag.2013.07.002>

Rafeyan, O., Darvishsefat, A.A., Babai, S., Mataji, A. (2011). Evaluation of pixel-based and object-based classification methods for tree identification using aerial images (Case study: a forestation in Chamestan-Nur). *Iranian Journal of Forest*, 2011(Issue 1).35-47.

https://www.ijf-isaforestry.ir/article_4638_1af7d353c23a926df372890c74917c21.pdf?lang=en

Rasouli, A.A. (2008). Principles of remote sensing image processing applications, with emphasis on satellite, *Tabriz University Press*, 777 pages.

https://jtcp.ut.ac.ir/article_76675.html

Schiewe, J. (2002). Segmentation of high-resolution remotely sensed data concepts, application and problems, in *Symposium on geospatial theory, processing and applications*, Ottawa, Canada, 235-242.

<https://www.isprs.org/proceedings/xxxiv/part4/pdfpapers/358.pdf>

Sharifi, L., Rasouli A. A., Hijazi, M.A., Rostamzadeh, H., 2012. Detecting changes in land use and land cover with object-oriented processing of satellite images (case study: Tabriz city), *Journal of Geography and City Planning* 17(44), 203-214. (In Persian).

<https://geoplanning.tabrizu.ac.ir>

Shataee, S.H., Darvishsefat, A.A., Sobhani, H. (2007). Comparing object-oriented and pixel classification methods based on satellite images of the forest type classification, *Journal of Faculty of Natural Resources*, Volume 60(3), 869-881.

Steinnochr, K.T., Leim, Y.S., kressler, F.P. (2000). Multiresorultion segmentation and optimum approach for high quality multi-scale image segmentation, *Herbert WichmannVerlag*, pp. 12-23.

<https://www.scirp.org/reference/referencespapers?referenceid=1875442>

- Wang, L., Sousa, W.P., Gong, P. (2004). Integration of object-based and pixel-based classification for mapping mangroves with IKONOS imagery, *International journal of Remote sensing*, 25(24): 5655-5668.
<https://doi.org/10.1080/014311602331291215>
- Yaghobzadeh, M., Akbarpour, A. (2011). The effect of satellite image classification algorithm based on curve number runoff and maximum flood discharge using GIS and RS, *Geography and Development* 9 (22):5-22.
- Yan, G. (2003). Pixel Based and Object Oriented Image for Coal Fire Research, <http://www.ITC.com> (accessed in July 2008). pp. 3-99.
- Yarahmadi, J., Rostamizad, Q., & Sa'i, H. (2018). Detecting changes in forest cover by object oriented method using satellite images in Ilganechai watershed of Arsbaran forests, sustainable management of Hyrkani forests, 1 (2), 59-79. (In Persian).
DOI: [10.9734/jgeesi/2024/v28i5769](https://doi.org/10.9734/jgeesi/2024/v28i5769)
- Yu, H.Y., Cheng, G., Ge, X.S., Lu, X.P. (2011). Object oriented land cover classification using ALS and GeoEye imagery over mining area, *Transactions Nonferrous Metals Society of China* 21:733-737.
[https://doi.org/10.1016/S1003-6326\(12\)61671-9](https://doi.org/10.1016/S1003-6326(12)61671-9)
- Yu, Q., Gong, P., Clinton, N., Biging, G., Kelly, M., Schirokauer, D. (2006). Object-Based detailed vegetation classification with airborne high spatial resolution remote sensing imagery, *Photogrammetric Engineering & Remote Sensing*, 72(7): 799-811.
DOI: [10.14358/PERS.72.7.799](https://doi.org/10.14358/PERS.72.7.799)
- Yue, A., Li, H. (2009). Pixel-based and object-oriented knowledge-based classification methods using SPOT5 Imagery, *WSEAS Transactions on Information Science and Applications*, ISSN: 1790-0832, pages 477-489.
<https://dl.acm.org/doi/10.5555/1553642.1553656>
- Zhou, W., Troy, A., Grove, M. (2005). Measuring Urban parcel lawn Greenness by using an object-oriented classification approach, *Rubenstein School of environment and natural Resources, University of Vermont, George D.Aiken Center*, 81.
DOI: [10.1109/IGARSS.2006.695](https://doi.org/10.1109/IGARSS.2006.695)