Research on LUCC in Nansi Lake Area Based on GF-1 Image

Qin Li¹, Guoqing Sang¹

¹Key Laboratory of Water Resources and Environmental Engineering in Universities of Shandong, School of Water Conservancy and Environment, University of Jinan, Jinan, Shandong, 250022, China

Qin Li, Key Laboratory of Water Resources and Environmental Engineering in Universities of Shandong, School of Water Conservancy and Environment, University of Jinan, Jinan, Shandong, 250022, China. e-mail: stu_liq@ujn.edu.cn

Abstract. Based on the high-resolution images of Nansi Lake, the multi-scale segmentation of eCognition and the object-oriented nearest neighbor method are used for classification and visual interpretation and correction. The results show that the classification method is relatively fast, the boundary of the ground class fits natural objects, the classification parameters can be classified based on panchromatic bands, and other spectral bands and indexes can be subdivided. According to the results, the order of land area in the Nansi lake basin is irrigated land > lake region > urban land > aquaculture water surface > paddy field > unused land > navigation channel > forest land > river channel.

1. Introduction

The research on land use and land cover has always been based on remote sensing image data. With the improvement of spatial resolution of remote sensing data, its classification accuracy has increased from 1km and 30m of MODIS and Landsat to 2m and 1m of GF-1 and GF-2. Along with the development of classification technology, classification software has been improved from simple spectral analysis (e.g. ENVI, ERDAS) to object-oriented classification [1-3]. Multi-scale, multi-level classification and multi-parameter analysis can be applied to the classification process, which can improve the classification efficiency and interpretation accuracy [4]. However, due to the regional differences of classification parameters and image data, the relevant parameters of classification using eCognition vary with different regions and images, and its parameter adjustment requires further research and analysis [5-6]. Nansi Lake is located in Weishan County and Jining City of Jining, Shandong Province. It is the only way to reach the Shandong section of the eastern route of the South-to-North Water Transfer Project. The monitoring of the land type in this area is helpful to grasp the changes of the water body in the lake area and the monitoring of the environment in this area in a timely manner, and provides a reference for the analysis of the land type in this area and the application of eCognition parameters in similar areas.

2. Research Area and Data Processing

2.1. Overview of Research Area

The research area is 2643.44 km². Gaofen data are provided by Shandong Data and Application Center of High Resolution Earth Observation System. PMS data for Gaofen No.1 includes blue, green, red and near infrared bands with a spatial resolution of 8m and panchromatic band data of 2m. Through ENVI
geometric correction, orthorectification and image fusion processing, 2m multispectral data are formed, and 5 layers of image data including panchromatic band are formed to participate in the classification of eCognition. The imaging time is January 2019. Albers equal product projection is adopted. The central meridian is 117.032, the first latitude is 35.383, and the second latitude is 34.369 in m.

2.2. eCognition parameter setting
According to the geographical features and focus of the research area, the study is classified into 9 categories: towns, grasslands, irrigated lands, rivers, woodlands, paddy fields, water bodies and fish ponds, and unused lands. In the eCognition classification parameter setting, the segmentation scale in multi-scale segmentation is set as the most basic parameter setting, and the most suitable scale should be selected according to the classification object and image features, instead of the smaller the better. The internal mean value of the classification object should be ensured, and the difference between the objects should be maximized. The segmentation should be carried out at 1000 scale according to the experimental study.

In the setting of local characteristic parameters, most panchromatic bands based on Gaofen data are used for range control, and then are subdivided by other parameters in combination with local characteristic values, such as fish ponds. As fish ponds are similar to paddy fields, the difference lies in vegetation coverage, hence green bands and panchromatic bands are selected for control in parameter setting. Through trial division, the full range function 280 – 325 is selected for the full color band gray value. The green band parameter selection is larger than the function slope graph to determine the range of fuzzy membership. If the object value is less than 1, the membership is 0. If the membership degree greater than 480 is 1, the membership degree value between 0 and 1 will be determined based on the selected function slope graph. Some classes are related to single-band values, such as urban classes. Their judgment is based on blue band, and they are selected to be greater than membership function. The thresholds are 600 and 1200, less than 600 are non-cities, more than 1200 are cities, and between 600 and 1200 they are determined as cities according to slope function. Other class parameters are shown in Table 1.

As shown in Table 1 for the parameter settings of each class, the channel is similar to the channel function and is manually modified after being classified into channels.

| Land Class    | Parameters                        | Threshold                                    |
|---------------|-----------------------------------|----------------------------------------------|
| Town          | Blue Band                         | greater than the membership function, threshold value 600~1200 |
| Irrigated land| Panchromatic Band, Shape Index    | Panchromatic Band: greater than membership function, threshold value 0~1500; Shape index: greater than membership function, 0~4 |
| river channel | Length/Width, Panchromatic Band   | Length/Width: greater than the membership function, 0~23; Panchromatic Band: greater than the membership function, threshold value 300~400; |
| Woodland      | Panchromatic Band, NDVI           | Panchromatic Band: greater than the membership function, threshold value 0~1800; NDVI: approximate range function, 0.7~1 |
| Paddy field   | Panchromatic Band, Green Band     | Panchromatic Band: full range function, 325~380 Green Band: greater than the membership function, threshold value 0~1800 |
| Lake region   | Panchromatic Band, Green Band     | Green band <650, Panchromatic band approximate 0~30 |
| Aquaculture   | Panchromatic Band, Green Band     | Green band: greater than function, threshold value 0~480. |
3. Classification results

3.1. Interpretation Results of Land Class

Through interpretation, the current distribution of land use and land cover in January 2019 was obtained. Taking the lake area as the center, it transited from the lake area, aquaculture water surface, paddy field and irrigated land in turn. At the outermost part, it was mainly dry land, with towns, grassland and forest land embedded therein. The total area of the research area is 2643.44 km$^2$, of which the largest category is irrigated land, 947.82 km$^2$, accounting for 35.86% of the total area. Secondly, the lake area is 497.86 km$^2$ and the urban land area is 484.72 km$^2$, accounting for 18.83% and 18.34% of the total area respectively, as shown in Table 2.

Table 2. Land types Area Statistics of Nansi Lake in 2019

| The canal | Town | River Channel | Lake region | Wood land | Irrigated land | Paddy field | Unused land | Aquaculture water surface | Whole area |
|-----------|------|---------------|-------------|-----------|----------------|-------------|-------------|----------------------------|------------|
| Area      | 11.16| 484.72        | 5.46        | 497.86    | 7.62           | 947.82      | 249.78      | 37.41                      | 401.61     | 2643.44                     |
| %         | 0.42 | 18.34         | 0.21        | 18.83     | 0.29           | 35.86       | 9.45        | 1.42                       | 15.19      | 100.00                      |

Figure 1. Land use and land cover status map of Nansi Lake in January 2019
3.2. Analysis of Land Class Parameters

The classified land class and the corresponding NDWI, NDSI, aspect ratio, shape index, panchromatic band, blue band, green band, red band and near infrared band numerical change ranges are shown in Figure 2, Tables 3 and Table 4. It can be seen that the land types can be divided into four groups based on panchromatic wave band: lake region and aquaculture water surface; paddy field; unused land and rivers; forest land, urban land and irrigated land. The blue wave band aquaculture water surface, lake area and paddy field are in the low value range, the unused land and urban land are in the high value range, and the others are in the middle value range. The distinguishing trend between green band and red band is the same, urban land is in the high value range, lake region is in the low value range, and other land types are in the middle value range. Near infrared band urban land is in the high value range, forest land is in the low value range, and other land is in the middle value range. NDWI and NDVI have a high negative correlation, reaching -0.97. Forest land is at extremely low value in NDWI and NDVI is at extremely high value. Other classifications are that NDVI in aquaculture water surface and lake area is negative and can enter classification parameters. For aspect ratio and shape index, the aspect ratio of river channel is obviously different from other land types above 5, which can be classified into classification parameters.

![Figure 2. The range of numerical variations in various panchromatic bands](image)

### Table 3. The index variation range of various classes and NDWI

| Class                      | NDWI   | NDVI   | NDSI   | Long/Width | Shape Index |
|----------------------------|--------|--------|--------|------------|-------------|
| Aquaculture water surface  | -0.8~0.6 | -0.1~0.8 | -0.4~0 | 1~4        | 1~9         |
| Unused land                | -0.8~0.3 | 0.2~0.8  | 0.05~0.3 | 1~4        | 3~11        |
| Woodland                   | -1~0.8  | 0.8~1   | 0~0.1  | 1~4        | 4~14        |
| Paddy Field                | -0.7~0.2 | 0~0.8   | -0.15~0.1 | 1~4      | 1~18        |
| River channel              | -0.8~0.2 | 0.2~0.9 | -0.1~0.1 | 5~35      | 2~14        |
| Irrigated land             | -0.9~0.3 | 0.4~0.9 | -0.1~0.15 | 1~8      | 1~5         |
| Lake region                | -0.8~0.6 | 0~0.8   | -0.2~0.1 | 1~16      | 1~13        |
| Town                       | -0.5~0  | 0~0.15  | 0~0.18 | 1~5        | 1~10        |

### Table 4. The variation range of class and spectral value

| Class                      | Panchromatic Band | Blue Band | Green Band | Red Band | Near Infrared Band |
|----------------------------|-------------------|-----------|------------|----------|-------------------|
| Aquaculture water surface  | 275~320           | 0~1500    | 250~750    | 250~750  | 250~750           |
4. Conclusions
Based on object-oriented classification, the division scale is 1,000 to form the most basic class contour line. The classification results are sorted into irrigated land > lake region > urban land > aquaculture water surface > paddy field > unused land > waterway > woodland > river channel according to the area. The largest category is irrigated land with 947.82 km$^2$, followed by lake district with 497.86 km$^2$ and urban land with 484.72 km$^2$. Through analysis, the classification based on Gaofen data is generally based on panchromatic band to classify the ground classes, and then the DN value of visible band and other indexes are used to refine the parameters. Object-oriented multi-scale division of land class classification is obviously better than traditional classification methods based on spectrum. NDVI, NDSI and other indexes and spectral operation results are applied to classification, which refines the classification parameters of land class and effectively improves the classification speed and accuracy.

Acknowledgments
The study is financially supported by The Provincial water conservancy scientific research Project(SDSLKY201808), the University of Jinan High GF data Application Training Special Project(XKY11744).

References
[1] Wang Y.Q., Qin F. Y., Yun S., etal.(2019) Land Cover Information Extraction of Dalinuoer Wetland Nature Reserve: Based on GF-1 Satellite Data and Object-oriented Classification. Chinese Agricultural Science Bulletin,35(10):137-141.
[2] Chen J. R., Zhou X. H., Lu X..(2018) Object-oriented Classification Method for Surface Features Based on Hierarchical and Multi-scale Segmentation. Jiangxi Cehui,4:26-29.
[3] Ma H. P., Zhang J. C.. (2018) Object-oriented Waters Information Extraction and Area Change Analysis: Taking Poyang Lake as an Example.Geomatics & Spatial Information Techcnology, 41(12):149-153.
[4] Wang T. J., Ren S. S., Xue M.. (2014) Research on hybrid object classification method based on eCognition. Bulletin of Surveying and Mapping,3:137-138.
[5] Shuai M. R., Xie Y. W., Yang P. F..(2018)Research on the classification of high-resolution remote sensing images based on eCognition. Wireless Internet Technology,11:98-99.
[6] Qin L. M..(2016) Research on object oriented high resolution image information extraction based on edge information enhancement. AnHui University of Science and Technology, Huainan.