HIGH-RESOLUTION SATELLITE IMAGERY ANALYSIS BASED ON OBJECTED-ORIENTED TECHNIQUE — THE CONTROL ZONE EXACTION IN "FOUR MOUNTAIN" REGION OF CHONGQING FOR EXAMPLE

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ABSTRACT:

The woodland which covers mainly the district in Jinyunshan Mountain ,Zhongliangshan Moutain, Tongluoshan Mountain and Mingyueshan Mountain area , is very important to accommodate ecological environment ， and is called the "lung" of Chongqing . But these limited resource is dieing out gradually in the process of urbanization and industrialization .In order to keep them from disappearing, we must make certain the distributing of the woodland and the impervious surface, setup corresponding control zone, and restrict human activities.This paper discusses about the extraction of woodland and impervious surface from spot5 images using the Object-oriented classification method. The high-resolution satellite images provide more detailed spatial information such as texture，shape，size and context rather than spectral information. Classification relies on the pixel-based approaches is limited at present。Typically，they have considerable difficulties in dealing with the rich information content of high-resolution data，they produce inconsistent classification results and "Salt and Pepper" , and they are far beyond the expectations in extracting the object of interest. While classification based on object-oriented can overcome these difficulties, and they produce results that could be understood more easily.This paper makes use of the object-oriented approach to the classification of high- resolution imagery, involves the segmentation of image data into objects at multiple scale levels. Class rules are generated using spectral signatures, shape and contextual relationships, and then used as a basis for the fuzzy classification of the imagery. The utilization of spectral, textural, shape properties and fuzzy thinking may reduce the uncertainty in the process of classification. The paper established the vegetation fraction based on the dimidiate pixel model to extract the woodland that need to be protected through investigation on the spot .These is little information in the shadow, so the paper extracts the shadow specially, then using class-related features to determine objects' belongings in the shadow .When it refers to impervious surface, the paper firstly constructs several classes to extract different buildings, then incorporate all of them to make the result more precisely. At the same time, combining with terrain and physiognomy analysis, and other thematic information, nature reserve, water conservation district and scenic area for example ,the paper ascertains the control district. The results show better overall accuracy of the object-oriented classification. The conclusion indicates that object- oriented analysis has great potential for extracting land cover information from high satellite imagery ,and can improve the level of automatization and intelligentization of high remote sensing data process and application。

1. Introduction

The woodland which covers mainly the district in Jinyunshan Mountain, Zhongliangshan Moutain, Tongluoshan Mountain and Mingyueshan Mountain area, is very important to accommodate ecological environment，and is called the "lung" of Chongqing. But these limited forest resource is dieing out gradually in the process of urbanization and industrialization. In order to promote urban economic, social and environmental developing harmoniously, the municipal government has made the decision to setup corresponding control zone in Jinyunshan Mountain, Zhongliangshan Moutain, Tongluoshan Mountain and Mingyueshan Mountain, the building activities of the control zone will be districted to make sure that the "lung " does not continue to be destroyed.

In the course of designating the ecological control zone in the"four-mountain " region ,first and foremost is to make clear of the distribution of woodland and impervious surface at present.Clearly it is hard to imagine investigating on the spot. It costs a lot, manpower, material and financial resources, in addition, the investigation time will be very long, and the accuracy and feasibility is questionable. Remote sensing technology has the advantages of objectivity, dynamic, real-time and accuracy, it is easy to extracte the woodland coverage and the distribution of the buildings with RS technology ,then we can easily make certain the control zone with the elevation data,slope and other information.

2. Object-oriented classfication technology

The traditional information extracted method from remote sensing images is based on pixel, it is primarily on the basis of spectral characteristics,that is the Eigenvector of the same kind features will be clustered in the same feature spaces, and the spectral characteristics of different features will be different, so they will cluster in different characteristics of the regional space. This technology is focus on partial and neglect the geometric structure of the whole-map, thereby seriously constraints the accuracy of the information extraction.It happens more frequently in mid and high-resolution satellite images. Although with the development of the remote sensing image processing and computer graphics, neural network classification simulatiing the human visual, experts classification system and pattern recognition technology were widely used, and these methods improve accuracy and effectiveness of classification indeed, but are still the pixel-oriented technology, and can not

fundamentally resolve the problems such as the large number of redundant data and "Salt and Pepper". High-resolution remote sensing image is rich in spatial information, the geometric features and texture information is more clearly.It is more convenient to cognitive the objects' attributes features such as the shape, texture, and other attributes. But they often contains less-band, the spectral characteristics are not so rich as space features. The pixel-oriented technology used in High-resolution imasges' information extraction could result large number of data redundant and waste of resources. In fact, pixel-oriented classfication technology can not satisfy the requirements to deal with high-resolution images. Here,the object-oriented technology as a new remote sensing image classification techniques has emerged, it can use not only the spectral characteristics, but also the geometric features and texture information flexiblely, and cand load people's thinking and expert knowledge, enhance the accuracy of feature classification greatly. Through segmentation, the object-oriented approach makes the image into different meaningful objects, the following step is based on those objects. Compared with the pixel-oriented method,it can solve the problem of "Salt and Pepper", and can be understood more easily.It produces the results more receivable ,interpretable and integral. we have adopted the object-oriented remote sensing image processing technology in control zone exaction in "four-mountain " region of Chongqing.

3. Study on extraction of woodland, impervious basede on Object-oriented technology

3.1 Data preparation

The "Four mountain" region including Jinyunshan Mountain, Zhongliangshan Moutain, Tongluoshan Mountain and Mingyueshan Mountain, covers the metropolitan area of Chongqing, Hechuan, Bishan, Jiangjin, Dianjiang, Liang Ping and Changshou, a total of 15 districts, more than 3,000 square kilometers.The remote sensing data includes two spot-5 images of March 2, 2006, and one of July 1, 2005.The resolution of one panchromatic band in spot-5 is 2.5 meter,and four multispectral bands, two for visible light (red, green), one near-infrared band and one short-wave infrared band,are 10 meter.

The pretreatments of remote sensing image data include fusion, geometric correction, mosaic, subset and so on,and sometimes radiation enhancement according to the actual needs. In this study, we compared several commonly fusion algorithms and eventually choosed pansharp(1) fusion algorithm, the texture of the fusion imaging is especially particular , and the correlation coefficient is high with the panchromatic images and multi-spectral images. When it comes to ortho correction, here we use 1:10000 DEM and topographic map , collect 8-12 control points and 3-4 checkpoints, the precision is to be controled in less than a pixel.

3.2 Image segmentation

Image segmentation is the foundation and key of remote sensing information extraction with object-oriented technology, it directly impacts the final classification accuracy. Image segmentation is is the way of region growing, beginning with one pixel, merged pixels and objests according to the spectral, space and other features into a semantic objest, the following step is based on those objects. The standard of image segmentation is that the image objects' average heterogeneity should be to minimize and average heterogeneity of pixel should be minimized.

Different types of objects have the most suitable segmentation scale in object -oriented classfication method, so multi-scale segmentation analysis is necessary. Each band of high-resolution images can reflect the land surface distinctly, so we think that they play the same importance, their weights ωc in image segmentation are the same. The scale should be smaller in impervious recognition (buildings, roads, etc.) than vegetation, through analysis,we found that the following scales (see table 1) can identify target clearly and can ensure the semantic recognition for all the objects.

	Layer Name	Layer 1	Layer 2
Weight	Segmentation Scale	25	100
	Color	0.6	0.6
	Shape	0.4	0.4
	Smoothness	0.5	0.5
	Heterogeneity	0.5	0.5

Table 1 parameters of multi-scale segmentation

3.2 Image objects classification

The feature is indeed the decisive factors in information extraction. For different objects, the characteristic or composition of characteristics used to recognise them are not the same, so it is very important to choose the right feature or combination of features. We establish different classes in different layers according to actual need, at the same time we can define the super-class and sub-class, analyze the most suitable feature or combination of features, establish the appropriate functions to carry through.

The building is typical artificial surface, what reflectes is the surface characteristics in images. The surface characteristics of the buildings are complex, we extracte the impervious surface in layer 1(see table 1), using the strategy of making a lot of small classies to extract different impervious surface then merge them into a bigger one. It is limited to extract information directly through the spectrum of original images. Through analyzing the spectrum of different impervious surface, we find that lots of impervious surface and water had a low value in NDVI (Normalized Difference Vegetation Index) image,the value of water's was more lower, but the value of vegetation's is relatively high. Some new impervious surface are mixed with dry land in NDVI image, but they are highlighted in green-band, so they can be distinguished. In addition, the old town district is mixed with water sometimes, but water can be eliminated by MNDWI(Modified Normalized Difference Water Index) and short-wave infrared,so they can be distinguished easily. There are also some buildings have different reflection characteristic in particular bands because of the specific color of the roof, such as the red roof has the high a value in the red-band,thus we could make a special class to extract. Furthermore the feature of linear objects(such as roads) is strengthened in MNDWI image (Figure 1), besides its spectral characteristics, the geometric characteristics of the road (linear features) are very prominent, so we also use shape index to extract.

$$NDVI = (Rnir - Rred) / (Rred + Rnir) \quad (1)$$

$$MNDWI = (RGreen - Rswir) / (Rgreen + Rswir) \quad (2)$$

In expression 1 and 2, Rnir is the reflectivity of near-infrared band, Rred is the reflectivity of red band, RGreen is the reflectivity of green band, Rswir is reflectivity of short-wave infrared.

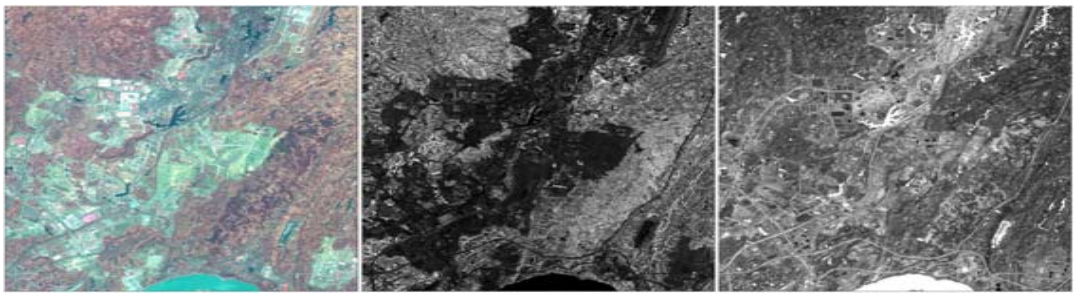

Figure 1 Comparison of spot pseudo-color image , NDVI (middle) and MNDWI images

The extraction of woodland and dense forests is in layer2 (see table 1). Woodland has an absorption Valley on red-band, and a reflection peak on near infrared and short-wave, woodland can be extracted through the mean value of these bands. The extraction of the dense forest is based on canopy density, that is vegetation coverage in remote sensing images. We establish the vegetation coverage model to extract dense forest through custom feature. There are three vegetation coverage inversion models at present(2): regression model, vegetation index method and pixel-decomposition model. The most simple and most practicable is the pixel-decomposition model, the formula of vegetation coverage f is calculated by expression 3.

$$f = (NDVI - NDVIsoil)/(NDVIveg - NDVIsoil) \quad (3)$$

NDVIsoil is the NDVI values covered by the pure soil, NDVIveg is the NDVI values covered by pure vegetation.

The advantage of the object -oriented classfication method to calculate vegetation coverage is that piexes are merged into semantics objects, those objects have more homogeneous leaf area index(LAI), so the vegetation coverage calculated by this method is impacted less by leaf area index, thus it can characterize the vegetation coverage better(3).

We determine the extraction standards of woodland and dense forest through outside survey on "Four mountains"region, then analyze their reflection in different images, linearly elevate f into the range 0-255, at last identify f larger than 88 can distinguish woodland and the dense forest that need to be protected through outside survey effectively.Furthermore,we find that the standard deviation values of green-band can also reflect vegetation coverage, so we can bring this feature into dense forest extraction as well.

In addition, we find the shadow is quite prominent in spot images. The spectral features and other information are of serious shortage because of the shadow, it is difficult to identify objects .Here, we extract shadow as a separate class.The value of the shadow is very low in brightness image and the near-infrared bands, we use these two features to extract shadow. And then use another type of feature(relative border to), if the feature is fuzzy greater than 0.11,wo consider it was caused by forest,so we can incorporate it into dense forest class,otherwise keep it as shadow.

We analyze the topography of the region and extract contours in 25 meter intervals after get the distribution of woodland, dense forest and the impervious surface, and with other thematic information such as the distribution of nature reserves ,scenic spots, water conservation areas and so on, designate the control zones in "Four mountains" region.

4. Analyst and Verification

Object-oriented information extraction technology also supports manual intervention, we can make some necessary manual intervention. In addition, it generated a lot of small polygons in various scales, we need merge these small polygons, the merge operation can be done on the same scale, and also on different scales,at last, we can get what we need.

We use sampling points generating test region (TTA Mask) to verify the accuracy of classification. The accuracy of the dense forest extraction reached 89.4%, accuracy of impervious surface reached 88.2%. The accuracy and reliability of the dense forest and impervious surface were also confirmed by outside survey, the results can satisfy the actual needs.

The results were shown in Figure 2 to 5.

5. Conclusion

The greatest advantage of object-oriented information extraction technology compared with traditional methods is using multi-scale segmentation considering spectral characteristics, geometric features and texture feature comprehensively, and generates meaningful image objects .The following classification is based on those homogeneous objects. It makes full use of image's spectrum information, texture information and topological relations, thus greatly increase the accuracy of the classification, decrease wrong classification pixels and solve "Salt and Pepper" phenomenon.
Object-oriented classification method has shown great potential, especially for high spatial resolution remote sensing images.But there are some issues still worthy for studying: ① The image segmentation scale directly impacts the accuracy of classification, different segmentation scale can strengthen some features, and also can restrain some other features, how to determine the best segmentation scale scientificly according to requirement; ② The selection of object characteristics, how to determine the best characteristics or combination of characteristics to achieve the best classification effect.

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Figure2 woodland

Figure3 dense forests

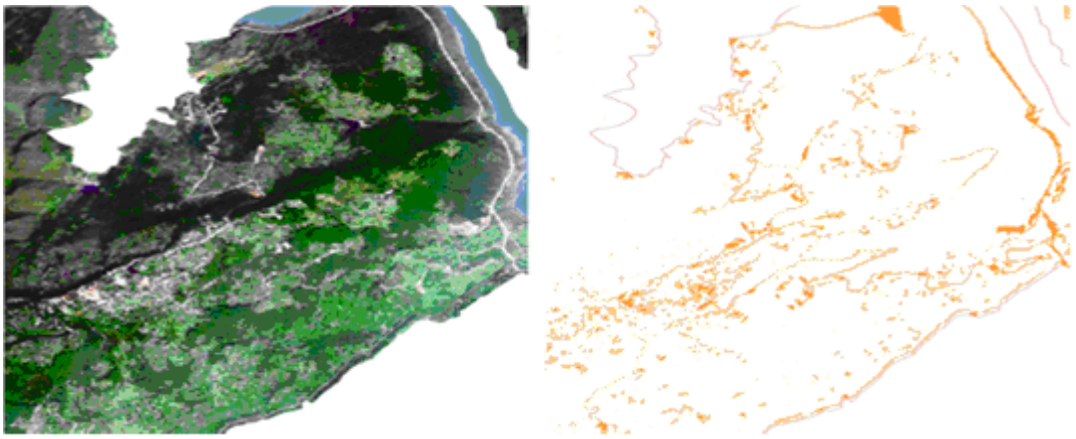

Figure 4 impervious surface

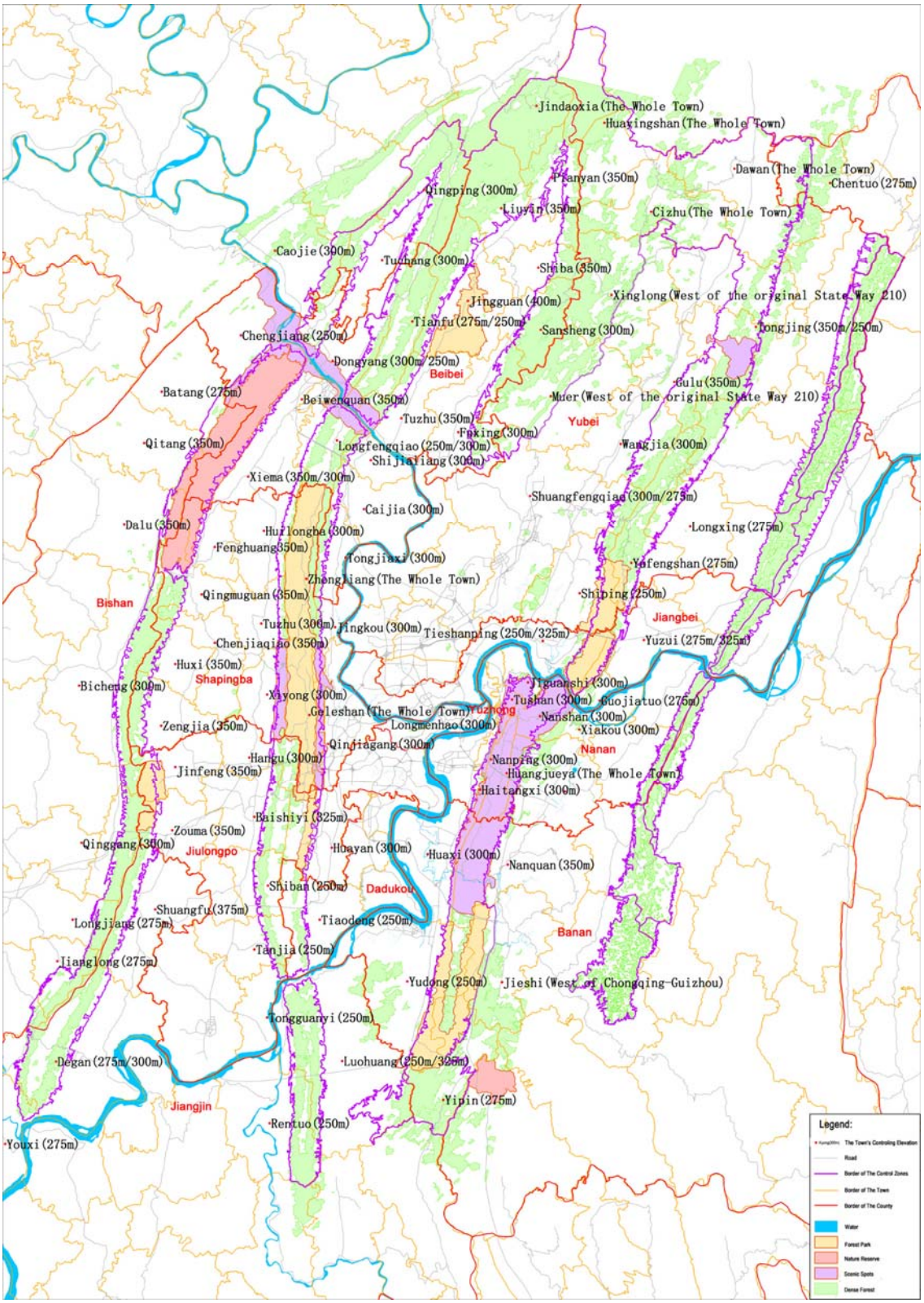

Figure 5 the sketch of control zones in "Four Mountain" region