

# RESEARCH ON “BEIJING 1” MICRO-SATELLITE IMAGE QUALITY AND LAND USE CLASSIFICATION PRECISION

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## ABSTRACT:

“Beijing 1” is one Micro-satellite of the international Disaster Monitoring Constellation (DMC). It was launched successfully in 2005, and has high-powered characteristic, such as high gaining data ability, high storage ability, high space resolution, high time resolution and low cost. At present it is necessary to make objective appraisal for image quality and application potential in different research field in order to provide beneficial reference for the satellite future design and application. In China, LUCC space-time database construction is one important domain in remote sensing technology application field, and mainly relied on foreign commercial satellite. Now “Beijing 1” Micro-satellite Image can be one kind of new data source. This paper taking LUCC as the application object, Researched on “Beijing 1” Micro-satellite multi-spectra Image Quality and Land Use Classification Precision. The main content and research method in the paper as followed: Image quality was studied through analyzing visual quality, spectrum characteristic and geometry correction precision. land use classification precision was studied through selecting characteristic variable, optimizing training sample and establishing classification template, constructing three different methods “Maximum Likelihood, Minimum Distance and Mahalanobis Distance” to make land use classification and appraise the classification precision. The research results show that: “Beijing 1” image has rich spectrum information, clear texture structure and good geometry performance. Image quality is fine and land use classification precision is high. Image can satisfy medium scale map request, can be widespread used in land use field and become the main data source that remote sensing data renews in land use research.

## 1. INSTRUCTIONS

“Beijing 1” is one Micro-satellite of the international Disaster Monitoring Constellation (DMC). It was launched successfully On October 27, 2005, and had high-powered characteristic, such as high gaining ability, high storage ability, high space resolution, high time resolution and low cost. “Beijing 1” Micro-satellite could gain multi-spectra data with 32 meter resolution and 600km×600km scan areas, at the same time, it could gain panchromatic images with 4 meter resolution and 24km×24km scan areas. After the entire DMC began to run, everyday it can provide the remote sensing images for any place in the world. “Beijing 1” Micro-satellite had important scientific value. It would change the history that China mainly depended on the foreign satellite remote sensing data. At present it is necessary to make objective appraisal for image quality and application potential in different research field in order to provide beneficial reference for the satellite future design and application.

In China, LUCC space-time database construction is one important domain in remote sensing technology application field. In the past, LUCC space-time database construction in China mainly relied on foreign commercial satellite (LANDSAT). But now TM data source was in the unstable condition now. Therefore, searching one new data source had been one urgent duty. “Beijing 1” Micro-satellite Image can be one kind of new data source. So this paper taking LUCC as the application object, researched on “Beijing 1” Micro-satellite multi-spectra Image Quality and Land Use Classification

Precision, aiming to accumulate experience for more application in difference field in future.

## 2. EXPLANATION OF METHODS

### 2.1 Data used

In the research, “Beijing 1” CCD data provided by Chinese 21st Century Spatial Technology Application Company was used. Data was received on November 14, 2005. Three wave bands respectively were 0.52 - 0.62μm (green), 0.63 - 0.69μm, (red), 0.76 - 0.90μm (near-infrared).The image cover scope was broad, including Beijing, Shijiazhuang and Tianjin. The northeast and northwest were mountainous areas, the southeast was Bohai Sea, and Beijing was located in the middle of image. Table 1 described other information about this image.

DataName	Resolution	Document size
“Beijing 1”	32meter	794.49cm×562.61cm
Data capability	Format	Element
1.00GB	TIF	22521×15948 element

Tab.1 Detailed situation of “Beijing 1” CCD data used in study

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## 2.2 Method of image quality appraisal

Image quality appraisal qualitatively analyzed and described "Beijing 1" image character by visual detection from some aspects, such as texture structure, data continuity, noise characteristic, radiation precision as well as interpretation ability and so on.

## 2.3 Method of land use classification

Supervised and unsupervised classification methods were used to extract the sample. First Initial classification was carried on in order to get the training area. Simultaneously, "the same thing with different spectrum, the different thing with same spectrum" category and region were founded for revision classification result. Then by selecting training sample and classification function, supervised classification was made, finally revised classification result by interpreter and made classification precision appraisal. During the supervised classification process, in order to contrast classification precision, three classification functions were selected. The maximum likelihood formula was as follows:

$$D = \ln(a_c) - [0.5 \ln(|Cov_c|)] - [0.5 (X - M_c)^T (Cov_c^{-1})(X - M_c)]$$

in the formula,  $D$ : Weighting distance,  $c$ : Some characteristic type,  $X$ : Element survey vector,  $M_c$ : Sample average vector of type  $c$ ,  $a_c$ : Percentage probability of any element belonging to type  $c$ ,  $Cov_c$ : Element covariance matrix of type  $c$ ,  $T$ : Transposition function. The minimum range formula was as follows:

$$d(x, M_i) = [\sum_{k=1}^n (x_k - m_{ik})^2]$$

in the formula:  $n$ : Wave band number,  $k$ : Some characteristic wave band,  $i$ : Some cluster center,  $M_i$ : sample  $i$  mean,  $M_{ik}$ : The  $i$ th kind centre and  $k$ th kind element value,  $d(x, M_i)$ : Distance of the element to the  $i$ th kind central( $M_i$ ). The Mahalanobis distance formula was as follows:

$$D = (X - M_c)^T (Cov_c^{-1})(X - M_c)$$

in the formula:  $D$ : Mahalanobis distance,  $c$ : Some specific kind,  $X$ : Element survey vector,  $M_c$ : Type  $c$  template average vector,  $Cov_c$ : Element covariance matrix in type  $c$  template,  $T$ : Transposition function.

## 2.4 Method of Classification Precision appraisal

Using ERDAS software, classification precision appraisal was finished. Stochastically 500 spots were extracted. After

determining accurate reference category of the sampling point, classification precision appraisal was finished. Appraisal results showed in confusion matrix. Overall precision and Kappa coefficient were extracted from the matrix. The value was bigger, classification precision was higher. The detailed flow was as follows:

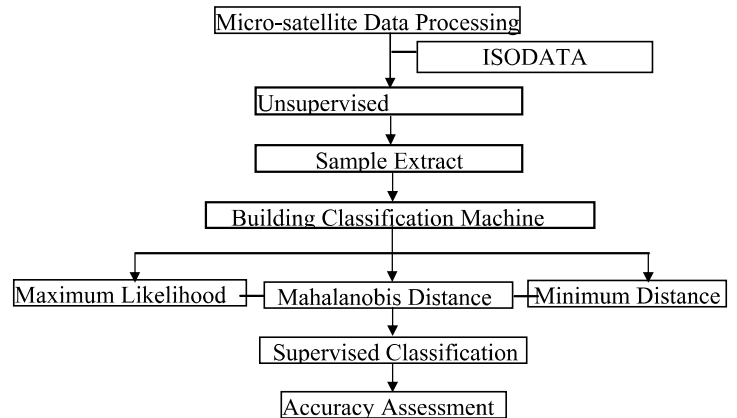


Fig.1 Image land use classification flow

## 3. RESULTS AND DISCUSSION

### 3.1 Visual analysis result

By visual detection, "Beijing 1" image spectrum information is rich. The texture structure is clear. Escaping belt and leaking belt phenomenon does not exist. Data continuity is good. There is no partially geometry distortion. The forest land, the lawn, the urban land, the countryside residential area, the reservoir and the pit pond can be distinguished clearly from the image. The mountain takes on seal brown (crag bare) and red, scarlet red (covered by vegetation). Water body outline is obvious, Because of different silt content, takes on different colour. The tiny drainage ditch is green. The reservoir and pit pond wer dark blue or black along with different depth. In the image Beijing built-up urban area outline is clear, but the city street texture is fuzzy. The whole interpret situation is good.

### 3.2 Spectrum information analysis result

In order to providing reference for land use computer automatic classification research, Get terrain feature spectrum diagram of curves (Figure 2), extracted different land spectrum information, analyzed image spectral signatures. From the chart, we can see: the water spectrum value in the wave band 1 was lower than the spectrum value in the wave band 2 and 3. Farming land, forest land and lawn were most obvious in wave band 1. The wave band 1 was green vegetation's high echo area. The wave band 2 was vegetation's low echo area. It was sensitive to the plant chlorophyll's absorption. Spectrum value of the Sand beach and construction land was high and the spectrum information was easy to get. But the urban land and the countryside residential area's curve characteristic were similar, and the forest land and the lawn curve type were similar. When making computer automatic classification, it was not easy to differentiate the information.

### 3.3 Geometry correction result

Based on TM data (adjusted by using 1:100,000 topographic maps), image geometry correction was made. 24 scenery TM CCD images (Fig.3) were necessary to carry on the comparison correction. In the correction process, used neighbour element resample, constant area division conical projection, and applied national unified central meridian and the double standard parallel, chose 397 control points (road junction, rivers junction and obviously object points). The mountainous area had the geometry distortion slightly, increased the control dot density. Because there was not obvious terrain feature in the Bohai Sea area, no point was chosen. After finishing image correction, mountainous area error was between 1.5-2.5 elements; plain area error was in 1-2 elements. Through contrast the same object point between remote sensing data and the topographic diagram, computed plane dimension absolute error to confirm "Beijing 1" Micro-satellite data precision. Image spot position error was in 2.02%, could satisfy the application request.

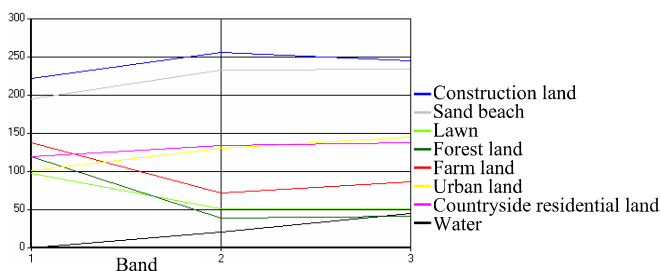


Fig.2 "Beijing 1" Micro-satellite spectrum characteristic of different land types

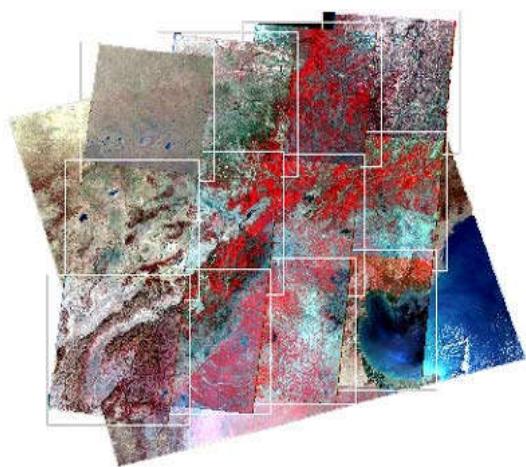


Fig.3 Contrast image Coverage area between "Beijing 1" Micro-satellite image and TM

### 3.4 Classification result

Between forest land and lawn, construction land and sand land, urban land and countryside residential area, spectral signatures were similar. So they were merged separately. Finally classification template included 5 kinds: The reservoir, the pit pond, the farming, the construction land and sand beach, the urban land and the countryside residential area, the forest land and the lawn. After the classification, the classification post-processing was made to obtain the ideal classification effect, mainly including colour evaluation, filtration analysis, recode

and so on. Then scientific classification result was obtained. Classification chart was as Fig.4.

### 3.5 Classification precision appraisal

By computation, classification precision was obtained as table 2:

Classification method	Overall precision	Kappa coefficient
Maximum Likelihood	89.45%	0.8436
Minimum Distance	73.93%	0.6240
Mahalanobis Distance	84.82%	0.7848

Tab. 2 Classification precision contrast in different method

We can see that classification precisions were high in maximum likelihood and Mahalanobis methods. Classification precision was low in the minimum range. The partial reasons were intrinsic flaws of the algorithm. The minimum range method had not considered mobility of the land use type. For instance, the urban land image element difference was very big. The distance was big to the template's mean value. Then, some elements that belong to the urban land use type were possibly divided to other categories by mistake. On the contrary, regarding some types that internal change was small, such as reservoir and pit pond, possibly classification elements were excessive, we divided them to the type that did not belonging to the type.

Because of many kinds of factor limit, for example, phase and same spectrum different things, three methods all had the phenomenon that terrain feature was divided by mistake. Spectral signatures between partial forest land and central city, reservoir, pit pond were extremely similar, several categories had wrong classification phenomenon. The countryside residential area assumed non-rule geometrical shape, and distributed periphery the farm land. In classification cluster processing, some land types that were smaller than 2 elements were merged to neighbour big category. Therefore, individual countryside residential areas were divided to the farm land type by mistake.

## 4. CONCLUSION

The study indicated that "Beijing 1" Micro-satellite CCD data has the certainly application value in the land use research field. "Beijing 1" remote sensing image coverage is broad. Wide range monitor has obvious superiority. The time resolution is high, on the aspect of land use dynamic monitor, application potential is huge.

Therefore the data have usability in land use research area, can be used in land use/cover, resources investigation and research, become one new data resource which the remote sensing data renew.

In future, image geometry correction needs to study further, according to its own characteristic. "Beijing 1" Micro-satellite data quantity is bigger; the geometry correction process needs more time-consuming. So When guaranteeing on high correction precision, it is necessary to guarantee quick processing, the operating speed, and reduce gamma controller change as far as possible. So the new request was set about geometry correction method.

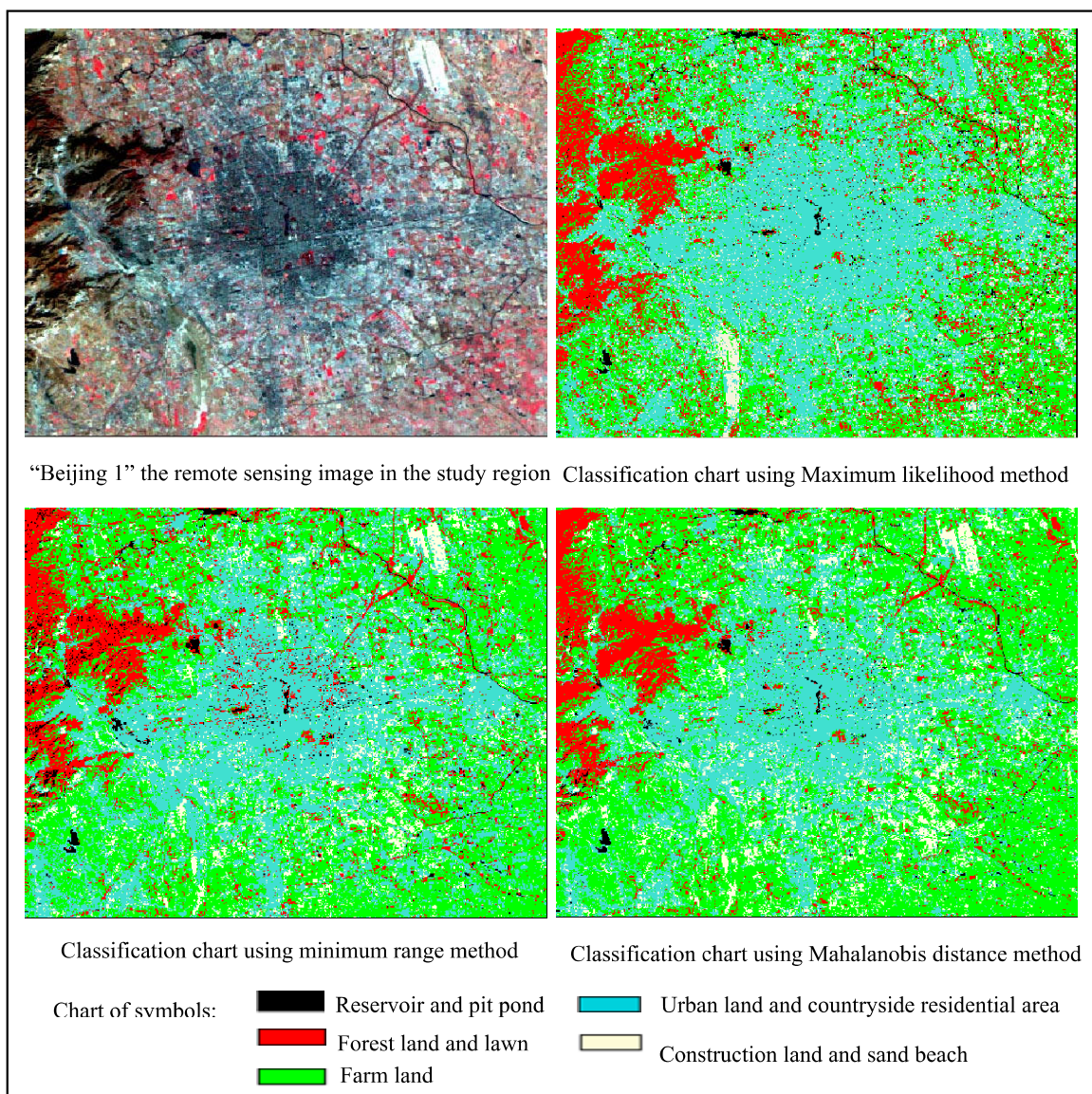


Fig.4 land use classification results in the study region

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