SHANDONG PROVINCIAL APPLICATION AND RESEARCH OF LAND-USING TRENDS REMOTE SENSING WATCHING

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ABSTRACT:

The project was one of the most important projects of PRC Land And Resources Ministry in 2001. Land-using Trends RS Watching was significant components of PRC Land And Resources Ministry new overall investigating of land and resources. The implementation of this project was very important to strengthen land management, to ensure dynamic state balance and occupying compensating balance of cultivated land total amount in Shandong province.

The project applied the software of PCI version 8.1 to rectify, to match, to inlay and to fuse with multi-sources and multi-timeliness remote sensing data to SPOT□TM and ETM satellites data, promoted spatial resolution of surface features and distinguishing capability of spectrum. The project applied three kinds of ways to pick up change land-using information, discovered change land-using information in maximal extent. The project fixed position of change map-speck spatial data precisely, determined the smallest map-speck area of different of satellites data, accomplished integration of RS and GPS, promoted accuracy and reliability of watching results, obtained integrated watching achievement of vector data□grid data and attribute data, by wild investigation□verification and GPS site surveying.

1. INTRODUCTION

The implementation of land-using trends Remote Sensing Watching was very important to strengthen land resources management, to ensure dynamic state balance and occupying compensating balance of cultivated land total amount in Shandong province. By monitoring could find out the change of land-using in time and accurate, comprehended the change trends□arrangement and scale of land-using, grasping the use situation of construction land and cultivated land, offered foundation information at present for city construction, gave serve to land enforcing law checking□the investigation□program□ and management□protection and use reasonable of land and resources, supplied effective land resources safeguard for national economy construction and society development.

2. TECHNIQUE ROUTE

2.1 Monitoring Time Interval

Monitoring duration was divided into October 1998 to October 2000 and October 2000 to October 2001 two time interval.

2.2 Monitoring Object

Monitoring object included the situation of small towns construction and development; the situation of city scale expanding and land-using overall program execution; the condition of fundamental farmland protection; the main monitoring object which using RS watching results checked land modification investigation was the change of construction land and cultivated land.

2.3 Technique Route

Adopting combination of multi-sources and multi-timeliness remote sensing data, improved spatial resolving power and ability of distinguishing spectrum. Computer automatic processing was combined with artificial visual interpretation. Applying three kinds of ways picked up changed information based on RS image of three timeliness and two time interval, checked each other, reduced error and omission of changed information. Changed information based on RS image and DLG, overlaid RS image with DLG, compared and analyzed all information, marked change map-speck of different from vector DLG. Making full use of land management professional information, analyzed RS information comprehensively. By combining inside works with wild works confirmed change map-speck be true or false□its type and extent, supplemented monitoring omission map-speck, guaranteed the reliability of RS watching results.

3. RECTIFYING, MATCHING, INLAYING

3.1 Rectifying

The way of geometry precise rectifying and matching: adopting PCI version 8.1 software, packed TM data into a bundle according to band 7□5□4□3□2□1, also as ETM data; selecting TM satellite image data band 7□4□3, analyzed and judged changed information, also as ETM satellite image data; SPOT satellite image data was adopted panchromatic band; band 8 of ETM satellite image data was panchromatic band too.

Image geometry precise rectifying was main adopted quadratic polynomial way, gray-level afresh sampling was adopted cubic convolution. Coordinates spatial transformation was establishing image spatial coordinates relation between being rectified previously and being rectified afterwards. Quadratic polynomial:

$$U_i = a_0 + a_1 x_i + a_2 y_i + a_3 x_i^2 + a_4 x_i y_i + a_5 y_i^2 \square$$

$$V_i = b_0 + b_1 x_i + b_2 y_i + b_3 x_i^2 + b_4 x_i y_i + b_5 y_i^2$$

In above formula, $U_i \square V_i$ was image coordinates rectified previously (number of rows and columns) of No.i control point; $x_i \square y_i$ was image coordinates or geography coordinates rectified afterwards of No.i control point; $a_n \square b_n \square n=1,2,3,4,5 \square$was coefficient of quadratic polynomial; a_0 ,b_0 was constant term of quadratic polynomial. Making use of above control point, solved coefficient of quadratic polynomial according to least square method. According to transformation function, solved spatial position of every pixel, so as to achieve correction purpose.

Adopting high precision cubic convolution inside insertion double sampled so as to determine homologous pixel value, the pixel value was endowed by surrounding 16 points carrying on cubic convolution inside insertion. In order to promote precision of geometry precise rectifying, a large number of control points were selected in 1:50000 scale topographic map, 4 scenes SPOT image whose range resolution was 10 meter.

In fact, the purpose of image matching was making same region image which timeliness and type was different possess same spatial coordinates system and same pixel dimension. Method of matching was divided into relative matching and absolute matching. Relative matching being based on certain image, went through coordinates transformation and insertion value, brought about other image matching with standard image. Absolute matching was correcting all image to unified coordinates system, namely 1954 year Beijing coordinates system. Because selecting control points was more complex and efficiency was lower from topographic map than from image, relative matching method was adopted.

3.2 Matching

The processing method of geometry precise rectifying and matching. There was only 4 scenes October 2001 SPOT image data in Weihai monitoring region, so high range resolution panchromatic SPOT image was applied to geometry precise rectifying. There was 35 piece of 1:50000 scale topographic map in Weihai monitoring region, at least 29 control points were selected from 1:50000 scale topographic map every scene image, at most 78 control points were selected, unchanged cross of ways and cross of thin rivers and cross of railways were object selected chiefly.

After 4 scenes October 2001 SPOT image being corrected was inlayed it was considered as standard image, 1 scene October 2001 ETM image was relative matched with it, 1 scene October 2000 ETM image and 1 scene October 1998 TM image was precise relative matched with it again.

Image geometry precise rectifying was checked by method of randomly reading points, 4 up to 5 feature points were even selected in corrected image, their coordinates value was read, and their coordinates value was compared to coordinates of corresponding points in topographic map or data of GPS site surveying, results of being compared was judged whether satisfied demand. Precision check of image matching was adopted fusing check and overlaying check.

3.3 Inlaying

Image inlaying and precision statistics. Because Weihai monitoring region was covered by 4 scenes SPOT image, October 2001 SPOT image of correction would be inlaid. The way of inlaying was first correcting, inlaying image with unified geography coordinates again. The advantage of this way was that demand of overlapping degree was low, in a certain extent, unfavorable influence to overall precision for low precision in mountains region and hilly country would be avoid.

Inlaid image of 4 scenes October 2001 SPOT was regarded as standard image, image matching precision statistic adopting quadratic polynomial way was figured as table 1.

Table 1 table of image matching precision statistic (unit: pixel)

matched image	control points num.	RMS error Mx	RMS error My	RMS error M	largest point position mean square error	Least point position mean square error
2001ETM/8band	31	0.23	0.32	0.39	0.80	0.06
2000ETM/8band	26	0.29	0.30	0.42	0.89	0.08
2000ETM/1-5,7band	32	0.28	0.21	0.35	0.72	0.06
2001ETM/1-5,7band	30	0.35	0.26	0.44	0.76	0.01
1998TM/1-5,7band	39	0.35	0.32	0.47	0.80	0.04

4 FUSING WITH MULTI-SOURCES AND MULTI-TIMELINESS REMOTE SENSING DATA

Data fusing included principally geometry space matching, along with synthesizing of spectrum feature and geometry characteristic. One purpose was promoting range resolution and spectrum resolution of satellite image, another purpose was enhancing accuracy of image interpretation, by fusing TM multi-spectrum data of two timeliness or multi-timeliness with SPOT panchromatic band. At the same time, intersecting fusing of two timeliness image would lead to protruding variation, and the fusing was helpful to checking changed information. Making use of feature variation fusing of single timeliness panchromatic data and multi-spectrum data, was main applied to aid discovering new increasing construction land. Making use of feature fusing of two timeliness multi-sources data, was main applied to promote boundary precision of change map- speck. The manufacture of background map was demanded to picture be distinct and color be bright-colored, especial to be convenient for interpretation.

Data pretreatment before fusing: by gray linear stretching and veins energy enhancement, promoted SPOT data part gray contrast and protruded veins details, strengthened veins energy and reduced noise to the full by filtering wave. In fusing image, the contribution of multi-spectrum data was its spectrum information. Before fusing, by color

enhancement and adjusting brightness and tone along with saturation, pulled open color contrast, demanded not highly to part veins, sometimes allowed weakening veins information to ensure effect of fusing map.

Combination of fusing image: there were 8 kinds of combination ways, 2001 year ETM multi-spectrum+2001 year SPOT panchromatic image, 2000 year ETM multi-spectrum+2000 year ETM panchromatic eighth band,1998 year TM multi-spectrum+2000 year ETM panchromatic eighth band, 2001 year SPOT panchromatic image+2000 year ETM multi-spectrum, 2001 year ETM multi-spectrum+2001 year ETM panchromatic eighth band, 2001 year ETM multi-spectrum+2000 year ETM panchromatic eighth band, 2000 year ETM multi-spectrum+2001 year ETM panchromatic eighth band.

Fusing way applied to IHS transformation. IHS transformation made color RGB three kinds of primary color separate themselves from, RGB three kinds of primary color was cut apart into hue H, color intensity I and degree of saturation S three weight. The advantage of IHS coding was able to separate intensity from color.

The main purpose of fusing image rear processing was improving visual sense effect of image further, strengthening special subject information, veins information was the most important. Fusing image would be processed through straight-square-map adjustment, USM sharpening, color balance, color intensity adjustment and degree of saturation adjustment, contrast enhancement and so on.

5 MULTI-SOURCES AND MULTI-TIMELINESS REMOTE SENSING DATA CHANGED INFORMATION PICKING UP

Applying the way of combining auto-discovering with artificial discovering picked up changed information. Adopting the method of spectrum feature variation and main composition analysis and false-color synthesis, picked up changed information in Weihai monitoring region, in order to prevent omission of changed information effectively.

Applying the means of man-computer interaction interpretation picked up change area in image of changed information enhancement, change area was depicted by manual way. The definition of change type was adopted to combining interactive visual interpretation with computer processing. The expression of changed information was as unit by monitoring region, change map-speck was numbered united according to the order of from left to right and from up to down, serial number of map-speck was sole in monitoring region. Confirmed change map-speck was depicted boundary of map-speck by red color, doubted change map-speck was depicted boundary of map-speck by yellow color. The size of selecting spectrum feature map-speck was site area of 300m*300m, its average value and variance was tested according to type of feature map-speck , its serial number was numbered according to the order of from left to right and from up to down, by Weihai monitoring region unit.

6 WILD INVESTIGATION AND CHECKING

The main task of wild investigation was collecting program map of fundamental farmland protection region and land modification investigation information; looking into change map-speck one by one, defining actual change situation; replenishing monitoring omission map-speck, at the same time surveying area of fragmental land-object on the site; modifying or replenishing concerned boundary; verifying spectrum features map-speck.

GPS wild investigation applied three case double frequency WILD200 GPS receiver to survey width and length of linear land-object on the spot, especial to new increasing roads and broadened roads; In order to verify the precision and accuracy of inside works interpretation, 15 percent of map-speck had been selected to survey its area and position in Weihai city jurisdiction over three town and one district.

7 PRECISION STATISTICS

Change map-speck situation statistics of expressing land-using classification interpretation attribute error was shown as table 2.

Table 2 change map-speck land-using attribute error of classification interpretation statistics

time interval	2000.10—2001.10, 2000ETM, 2001SPOT						
monitoring region	map-speck total amount	change amount	percent	unchanged amount	percent	2000~6660m^2 amount	more than 6660m^2 amount
Weihai	267	243	91.0	24	9.0	58	209
Huancui	89	85	95.5	4	4.5	19	70
Rongcheng	74	64	86.5	10	13.5	18	56
Wendeng	60	51	85.0	9	15.0	11	49
Rushan	44	43	97.7	1	2.3	10	34
The least map-speck area which could be discovered was 2000m^2							
time interval	1998.10—2000.10, 1998TM, 2000ETM						
monitoring region	map-speck total amount	change amount	percent	unchanged amount	percent	2000~6660m^2 amount	more than 6660m^2 amount
Weihai	117	100	85.5	17	14.5		117
Huancui	35	31	88.6	4	11.4		35
Rongcheng	30	26	86.7	4	13.3		30
Wendeng	29	21	72.4	8	27.6		29
Rushan	23	22	95.7	1	4.3		23
The least map-speck area which could be discovered was 6660m^2							

The attribute of change map-speck had been verified 100 percent. By wild investigation checking, attribute precision of straight inside works interpretation overall monitoring region reached average 91.0 percent during October 2000 to October 2001, the highest 97.7 percent, the lowest 85.0 percent; attribute precision of straight inside works interpretation overall monitoring region reached average 85.5 percent during October 1998 to October 2000, the highest 95.7 percent, the lowest 72.4 percent; inside works error interpretation was main caused by that although land cover of single map-speck had been changed, and seeing from image, the spectrum and veins of this map-speck had been changed during previous timeliness to behind timeliness too, but land-using classification had not been changed.

The obtaining of theoretic value: it was limited to gaining true value this monitoring, map-speck area which GPS wild investigation actual data and land modification investigation area was identical with inside works monitoring area in Weihai city jurisdiction over three town and one district was considered true value to carry on precision evaluating.

Precision evaluation. Area relative mean square error of single map-speck RS monitoring, its value was 8.5 percent calculated with RS monitoring data during October 2000 to October 2001; its value was 10.3 percent calculated with RS monitoring data during October 1998 to October 2000; two results was both less than 15 percent, conformed to demand.

Area omission error of small map-speck, its value accounted for 4.8 percent of the total monitoring area during October 2000 to October 2001; its value accounted for more than 9.2 percent of total monitoring area, map-speck of less than 6660m^2 could not be discovered fundamentally. The main reason was that there was only TM multi-spectrum data on October 1998,but there was only

panchromatic image ETM data of 15m spatial resolution eighth band on October 2000.

The area sum relative mean square error of causing by RS area measuring and counting overall sum of RS monitoring area on whole monitoring region, its value was 0.6 percent during October 2000 to October 2001; its value was 1.5 percent during October 1998 to October 2000.

8 CONCLUDING REMARKS

Applying advanced PCI 8.1 version software to go in for inside works interpretation, land-using changed information had been discovered in the greatest extent on the situation of combination of various data type; close integration of GPS and RS had been achieved.

This project accomplished unified display and transferring allocation management, formed change map-speck information management system, established various land classification spectrum feature map-speck image database, obtained the monitoring achievement integrated by paper drawing, vector graph, image, text data.

Adopting DOM and DEM to rectify mountain area satellites image, could promote correction precision to a great extent. Applying various methods to pick up change map-speck information, could check each other just as going on inside works, reduced the occasion of error and omission.

Making use of SPOT data of 10m spatial resolution, could discovered change map-speck of more than 2000m^2 area. Making use of ETM data of 15m spatial resolution, could discovered change map-speck of more than 6660m^2 area.

Land-using modification investigation should go on modification according to actual situation, and accomplished continuity of drawing with statistics data. Land-using modification investigation methods and step along with offering achievement should as far as possible accomplish identical with RS monitoring works, should make two workss be replenished and be perfect together, achieved the effect of complement each other.

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