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EVALUATION OF CBERS-1 DATA QUALITY AND ITS APPLICATION TO SUSTAINABLE DEVELOPMENT IN JIANGNING

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ABSTRACT It is important to evaluate data quality of the China-Brazil Earth Resource Satellite (CBERS-1) data with the application of the data to various fields effectively. In this paper, the major technical performance index of CBERS-1 is given and compares with the SPOT data. And the data received by high resolving power CCD camera (19.5m) is selected. The study data include three wave bands which are the second, third, fourth wave band. The topical study area is chosen from the Jiangning of CBERS-1 CCD data, the size is 1180 multiply 1180 pixels. First the CBERS-1 data is removed of stripes and processed by geometric correction. And the data quality is evaluated. Then the image is integrated with the SPIN-2 (2m) image by IHS transformation. And the merged images are analyzed. From that, it is to be sure that the CBERS-1 data could be used to updating of topographic map database on the scale of 1:100,000 or 1:250,000 mapping of land use from multi-spectral classification growing monitoring of crops and analysis of agriculture structure adjustment etc. The CBERS-1 data will have wide application prospect in the sustainable development project of Jiangning.

0.INTRODUCTION

The CBERS-1 has been launched in Oct.14, 1999. Its aim is to be applied to the inspection of Earth Resources and Environment. Its spatial resolution is 19.5m and is higher than the TM. And it is closely to the SPOT-4 data. The CBERS-1 data removed of stripes and processed by geometric correction is better. In whole, it could be applied to extraction of special information, such as land use, forest cover, geology and agriculture, etc. (Wang et al. 2000, Zhao et al. 2000, Zhao et al. 2001).

In order to apply the data to various fields effectively, it is very necessary to study on data quality and take application demonstration research on CBERS-1. In this paper, the technical performance index of CBERS-1 compared to the SPOT-4 is listed in table 1. And it is closed to the SPOT-4. The data quality of CBERS-1 is evaluated from spatial resolution, geometric accurate and stripe and noise. Then the CBERS-1 data is integrated with the high spatial resolution data SPIN-2 (2m). The IHS transformation is explored. The CBERS-1 image is more clearly so that it is suitable for thematic information extraction. And it is proved that the CBERS-1 data could be used to updating of topographic map database on the scale of 1:100,000 or 1:250,000 mapping of land use from multi-spectral classification growing monitoring of crops and analysis of agriculture structure adjustment etc. Finally application research on land use change and trends in Jiangning is given. And it will have wide application in the sustainable development project of Jiangning.

Table 1 Technical Performance Index

Item	CBERS-1	SPOT-4
Orbit Height	778Km	832Km
Dip angle	98.2°	98.7°
Time of Arrive Orbit	10:30	10:30±15
Move Period	26d	26d
Main Load	CCD IRMSS WFI	HRVIR VI
Land Resolution	CCD: B1 0.45-0.52 20m B2 0.52-0.59 20m B3 0.63-0.69 20m B4 0.77-0.89 20m B5 0.51-0.73 20m IRMSS: B6 0.5-0.9 80m B7 1.55-1.75 80m B8 2.08-2.35 80m B9 10.4-12.5 160m WFI: B10 0.63-0.69 256m B11 0.77-0.89 256m	HRVIR: 0.50-0.59 20m 0.61-0.68 10m 0.78-0.89 20m 1.50-1.70 20m VI: 0.43-0.47 1000m 0.61-0.68 1000m 0.78-0.80 1000m 1.58-1.75 1000m

1. DATA QUALITY ANALYSIS

1.1 Spatial Resolution

From the composed image (no geometric correction), select ten or more homonymic control points relative to topographic map (scale 1:100000). Measure their pixel coordinates and count distances between two points each other. Finally the distance on image divided by the ground distance on topographic map is pixel spatial resolution.

1.1.1 Compared with SPOT-4 Image Select twelve homonymic points in the CBERS-1 image and the SPOT-4 image (geometric correction), count the pixel spatial resolution of the CBERS-1 image, its average is 19.392 m.

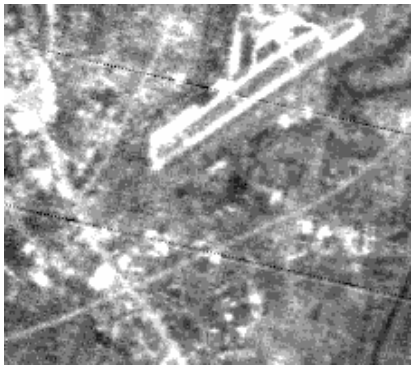
1.1.2 Compared with Topographic Map (Scale 1:100000) Select twelve homonymy control points clearly in the CBERS-1 image and the topographic map (scale 1:100000), count the distances of the points, the pixel spatial resolution of the CBERS-1 image is 19.412m. As a whole, the average spatial resolution of CBERS-1 image is 19.4m. Therefore, the satellite achieves design requirement.

1.2 Geometric Accuracy

From the CBERS-1 image (geometric correction), select homonymy points and homonymy ground objects in topographic map (scale 1:100000), finally measure out their coordinate. In contrast to geographic coordinate spatial distance and spatial area in the image with those in the map, the point error is less than 40 meters, and the spatial distance error is less than 20 meters.

1.3 Stripe and Noise

Looking into the original image (Figure 1 (a) (b)), it is clear that noise is stochastic distribution in its range. And the wave band 2 has distinct stripes. It is proved that the pixels of wave band 2 occur whole move. And the pixels move zero point six in x axes, one point five in y axes. That is, there are pixel errors between wave bands. Therefore, the CBERS-1 image is blurry. But the image is better after it is preprocessed.



(a) Band 2

(b) Band 3

Figure 1 The Original Images of CBERS-1

2. THEMATIC INFORMATION EXTRACTION

2.1 Test Area and Data Sets

The study site (the Jiangning area) situated in the middle part of Nanjing city lies to the south of the Yangtse River. And it locates in the southwest of Jiangsu Province. The geo-coordinate is E118º31´~E119º04´, N31º38´~N32º13´. In the field, there are many waters, such as reservoirs lakes ponds, etc.

The data set is the CBERS-1 CCD data (12/10/1999) and the SPIN-2 data (2000). The CCD data include three wave bands of Jiangning which are the second, third, fourth wave band. Its spatial resolution is 19.5m, and the SPIN-2 is 2m. Therefore the spatial resolution of CBERS-1 is higher than the TM and MSS. It is appropriate to the SPOT-4. The study site is 1180 by 1180 pixels. In addition, the CBERS-1 image is registered to the topography map that the scale is 1:100,000. And the CBERS-1 image is strengthened by linear strengthen or histogram equalization.

The CBERS-1 image reflects clearly more information such as the Yangtse River, lake, paddyfield, aerodrome, town resident area and road, etc. Using supervised classification and unsupervised classification, typical ground objects can be extracted from the CBERS-1 data. At the same time, the CBERS-1 data could be used to update of small scale of topographic map, making land use map on the scale of 1:250000, 1:100000. For example, the traffics and the resident area is changed quickly, it can be updated by the CBERS-1 data. (See Figure 2, Figure 3)

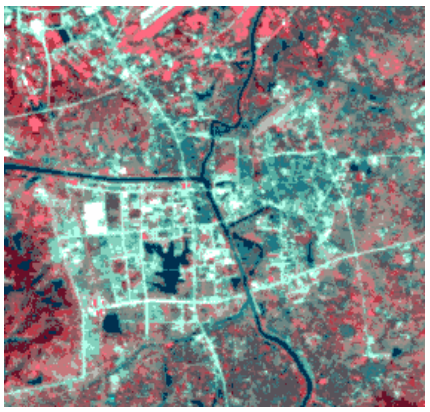


Figure 2 The Thematic Photomap of CBERS-1

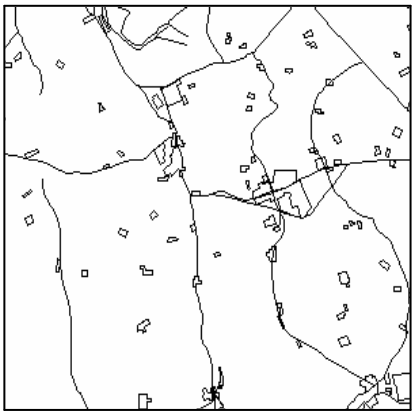


Figure 3 The Topographic Map on a Scale of 1:100000 in

1981 (The Traffics and The Resident Area)

2.2 Land Use Mapping from Multi-spectral Classification

For the CBERS-1 CCD 2 3 4 data , it have been made image interpret by man-machine conversation alternately using ERDAS imagine8.3. According to regulation of Land Use Remotely Sensing dynamic monitoring (TD/T1010-1999), land classification have been done. It could plot out the main types those are plowland, garden plot, grassland, residential area, traffic land, water area and unused land. And the CBERS-1 has the same effect compared with the Landsat TM and SPOT-4, it can be used to make Jiangsu province land use map on the scale of 1:100000 or Jiangning land use map on the scale of 1:70000.

2.3 Crops Growing Monitoring and Agriculture Structure Adjustment Analysis

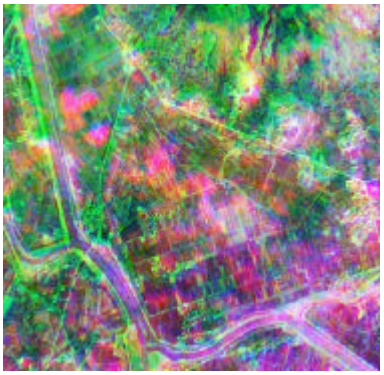
From the CBERS-1 image in Nov. 1999, we can distinguish the wheat with the vegetable or the forest according to the NDVI. From the CBERS-1 image in May 2000, we can also distinguish the cole with the wheat. The CBERS-1 image can reflect clearly the distribution of reservoir and pond in low hillock district of Jiangning. And it can also show the distribution of man-made rearing pond in plain section of Jiangning. Not only it represents adequately the geographical sight of water region and inundated area in Jiangning, but also reflects part status of agriculture structure adjustment of Jiangning in recent years (For example, it includes the proportion of the wheat and the cole, the shift state of the vegetable, the construction of rearing pond, etc.)

2.4 Updating of Basic Geographic Map

Basic geographic map of Jiangning is a digital map composed by cartographic map from 1980 to 1990. And it have accurate mathematic basis, therefore it can be regarded as the basis of geometric correction of the CBERS-1 data. Whereas, town construct is increasing highly such as highway, watercourse, etc. The CBERS-1 image shows the newest scene of ground objects, is the best data for update of basic geographic map. And it can meet update of basic geographic map on the scale of 1:100,000 or 1:250,000.

2.5 Fusion of CBERS-1 data with SPIN-2

The CBERS-1 data is fused with the SPIN-2 data using IHS transformation. In the first, the CBERS-1 image takes resample by bilinear interpolation method compared to the SPIN-2 image's resolution. And the resampled image is strengthened by some methods and taken IHS transformation. Then using the SPIN-2 image replaces I weight. And it is stacked with the H S weight. Finally the stacked images by reverse transformation get to the RGB space (See the Figure 4). The original image of the CBERS-1 is as follows in Figure 5.



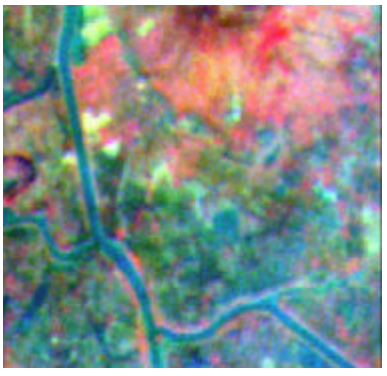


Figure 4 The Fusion Images of CBERS-1 Figure 5 The Original Image of CBERS-1

The CCD image spatial resolution is improved by the IHS transformation. From Figure 4, it is clearly that the texture of the processed image is distinct. And its multi-spectral information is preserving. In the image, the bridge through the Qinhuai River is more clearly. The ridges between fields can be seen. And the crops' growing can be distinguished by the different color. The waters do so.

Compared the Figure 4 with the Figure 5, the different states of varied surface features are more distinctly than the raw image. Especially the linear surface features are easily to be extracted from the image. And it can be used to updating of topographic map database on the scale of 1:100,000 or 1:250,000 mapping of land use from multi-spectral classification growing monitoring of crops and analysis of agriculture structure adjustment etc. Therefore the CBERS-1 data could be used to build and renew the resource database of Jiangning. And it could be the best data for monitoring the land use dynamic change and trends in Jiangning. It serves as the sustainable development of Jiangning.

3. APPLICATION RESEARCH ON LAND USE CHANGE AND TRENDS IN JIANGNING

Jiangning has quite a variety of land shape and land use types. In land use type, those of hills and mounds are widely different from those of plains. Their differences lie in the internal structure of agricultural land, in the ratio of construction land and land reserves, and in land development and utilization.

In Jiangning, cultivation began early in history and agriculture dominated in the economy ever since. For all the agricultural production in these years, nearly all the proto vegetation in the area have been destroyed. They have been substituted by secondary vegetation, including artificial timber forest and bamboo forest, and planting vegetation.

Since 1949, the agricultural land use has evolved through the following stages.

(1) A large-scale construction of basic hydraulic infrastructure: reservoirs were built in hills, fields were divided into squares and lands were leveled.
(2) Dry lands were transformed into water fields, low mountains and hills reclaimed, water stored in small hill reservoirs served as primary sources, and water from Yangtse river was elevated four or five steps to be utilized.
(3) Some water fields in hills lacking water supply were reformed into dry lands and low lands with poor productivity were changed into ponds raising fishes.
(4) To protect environment, part of farmland were made back to forestland in Danyang and Shangfeng town; some lands got integrated and sightseeing strip of agricultural was founded.

Since 1980, the area of non-agriculture use land has got expanded. Land use type has taken place great changes. The land use changes are contingent upon adjustment in industrial structure. With great re-adjustment in the industrial structure, the field industrial output value outstripped for the first time by doubling the total sum of farming, forestry, animal husbandry, fishery and sidelines in 1986. In 1998, the value even became 18.9 times higher than the sum.

Due to the construction of development zones industry developed rapidly in Jiangning. Since 1992, Jiangning initiated its first economic and technological development zone, and the field founded around the area private-run technological garden (state-level) and Jiangning Trade Center. There appeared three rural industrial districts, eight specialized markets and three major markets. These physical constructions greatly altered the land use situation in Jiangning, the farmland in plain appeared great reduction, the mound got leveled and vegetation of which suffered

considerable loss. According to the calculation, from 1989 to 1998, there was a total loss of 2,861 hectare farmland, which mainly distributed in Jiangning (30%), Dongshan(20%), Lukou(20%) and Guli(10%). Most of the farmland became infrastructure such as industrial garden, airport, highway, etc. The others were used to build houses or transfer to forestland. Boom of development zone in towns and of house building with affluent farmers led a wild occupation of farmland. In comparison, the land reserves to be utilized are lacking and those to be farmed are even less.

The land use extent of Jiangning is considerably large, but its level is not high. In spite of the extent of development, the land use is not in depth and is too extensive. Among the land used for agriculture, fields, gardens, woods and water area with low production accounted for a high ratio, and they are concentrated in the hills and mounds. In plain area, farmland taken up for development zones was not fully utilized actually and some of it even lay un-utilized.

According to the TM data in 1996 and the CBERS-1 data in 1999, the land use changes have been analyzed. And it shows that the location and present stage of the area has the greatest changes. Such comparison will help to provide more detailed information for sustainable development of land use in Jiangning.

4. CONCLUSIONS AND DISCUSSIONS

In the paper, the data quality of the CBERS-1 data is evaluated. Through analysis of the CBERS-1 data, it is to be sure that it is usable. It is better than the TM data. It can be extracted more information through fusion with SPIN-2 data. In conclusion, the CBERS-1 data could be used to many fields, such as land use, forest cover, geology and agriculture, etc. Especially it could be applied to serve as the sustainable development of natural resources.

However, there are some stripes in the image. We search for the cause through image processing and analysis. So we can give reference to improve the sensor of the succeed earth resources satellite.

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