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PILOT APPLICATION OF CBERS-1 DATA ON THE ECOLOGICAL BUILDING IN THE DESERTIFICATION AREAS OF WESTERN CHINA*

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ABSTRACT: This paper is a synopsis to the Background of the ongoing project "A Pilot Application of the CBERS-1 data on the Ecological Development in the Desertification Region of Western China", technical analysis on the CBERS-1 data application in forestry, the main components of the project include the overall technical scenario, applied research and demonstration targets, subproject and monographic application arrangement, primary technique specification, the image pre-processing of the CBERS-1, and the applied results and project extension etc. The ongoing project would promote the extending application of CBERS-1 data in forest sectors and would generate a far-reaching significance to the ecological building and sustainable development in the western China.

1. PROJECT BACKGROUND

1.1 After Rio Conference On Environment and Development, the international community has devoted more concern to the environment and development issues for mankind and the sustainable development of the society. The Chinese government had proactively participated the signature of related international conventions and undertook commensurate responsibilities and obligations, Such as the "UN Convention To Combat Desertification", the "Wetland Convention, International" etc.. Thus, the Chinese government had instructed the forest sectors in responsible for the following works of combating desertification, prevention and control the sandy desertification, wetland conservation and monitoring, wild fauna and flora conservation and monitoring etc.. With the further implementing of the sustainable strategy in China, the traditional realm of forestry activities expanded substantially. It had from an economic property basically turned to an ecological building property as the mainstay. The forestry ecological building is basically taking the nationwide afforestation as the foundation with the focus mainly on the key forestry ecological project and the ecological environment increasingly deteriorated areas should be firstly treated.

1.2 China is a most populous developing country and also one of the countries seriously jeopardized by desertification in the world. Especially, in the western part of this country where except arid climate, short of water and with rare vegetation, the contradiction between environment and development is very acute and the ecological environment is also extremely fragile. It has therefore greatly restricted the local socio-economic growth and progress. During the beginning of a new millennium, China launched the ambitious western development initiative with the core of promoting a concerted development of ecological building and economic growth. The forestry ecological building project is centerpiece of ecological building in those areas. Conducting timely monitoring to the status and the progress of ecological environment, the effect of the project, and coming up qualitative, quantitative and location analysis and assessment, it embody very important social significance and a high practical value. This is just the applied realm of the satellite remote sensing technique can develop its technical superiority in a full play.

2. TECHNICAL ANALYSIS OF THE CBERS-1 ON ITS APPLICATION IN FORESTRY

The task of forestry remote sensing is by use of the aerospace remote sensing technique to collect the information related to the forestry resource and environment. To establish a management information system of forest resources and environment with their attribute, thematic map and image data. It is aimed at to serve for the protection of forestry resource and environment as well as for the ecological and social sustainable development. The application of forest remote sensing requires that satellite remote sensing data should have the spectrum waveband composition that can reflect the forestry resources and environment features, and a higher spatial resolution and the excellent time phase. Also it requires that the applicators should have professional knowledge of forestry science and satellite remote sensing spectrum of the ground object.

2.1 Spectrum Waveband and Waveband Range

So far, the CCD data product provided by CBERS-1 have five spectrum wavebands, of which, the spectrum range of B1-B4 is

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basically similar to 1-4 waveband of TM. B1-B3 is of visible light spectrum. B4 is the only near infrared waveband and the range of wave length is narrow at 0.77-0.89, B5 is the panchromatic waveband of 0.51 –0.73. Although the range of the wave length of the near infrared waveband of CBERS-1 CCD is much narrow and it would in a certain degree impact the collect of the vegetation information, especially, the information of vegetation growth, however, it could basically reflect the waveband range covered the vegetation growth. And it also possesses the required range of waveband for calculatingthe vegetation index. Thus, it can be used to collect the thematic information of vegetation, land cover and land use closely related to the forestry resource and environment.

2.2 Radiation and Geometric Errors

Initially, the CBERS-1 CCD data product of the second grade exists radiation errors and noise luminous point, longitudinal and transversal stripe, and at the same time, the different waveband could be matched only after independently correctly. Since Oct. 2000, owing to the improvement of the image processing software package of China Resource Satellite Application Center, the quality of the CCD second grade data product of the CBERS-1 available to the end-users has been greatly improved and the abovementioned problems had been basically tackled.

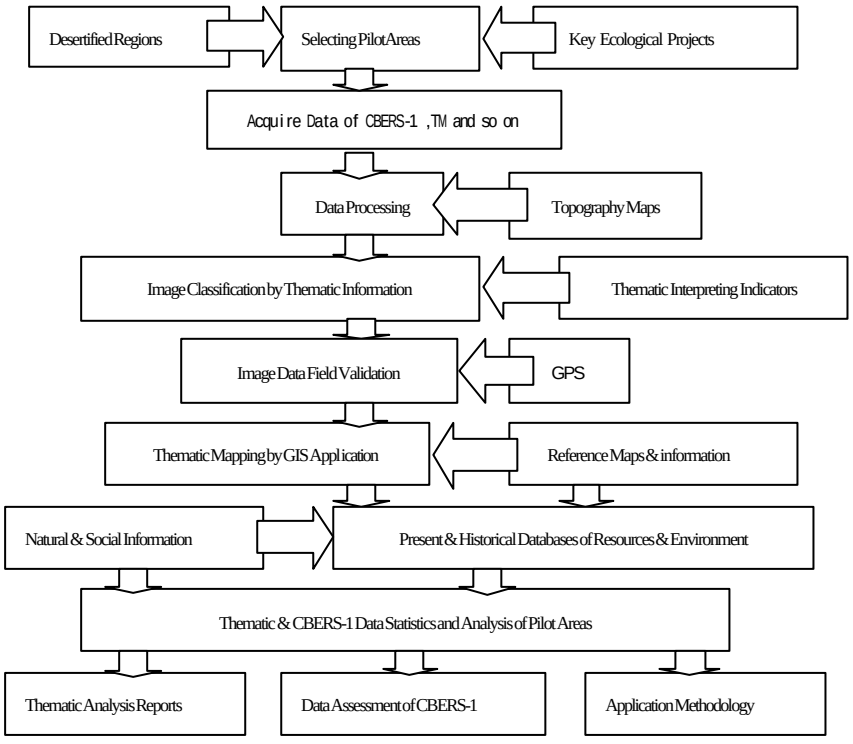
2.3 The Cycle of Data Receiving

The CCD camera of CBERS-1 possesses the function of side looking. But under the general conditions, the time cycle of receiving the CBERS-1 CCD data is 26 days in the same locality. In addition, The CBERS-1 also provides the infrared multi-spectrum data of four wavebands

3. PROJECT IMPLEMENTING COMPONENTS

3.1 Overall Project Technical Scenario

The selection is focused on the typical ecological building area influenced by the land desertification (mainly the sandy desertification) in the western China. In accordance with the requirements of application demonstration, the technical methodology of comprehensive remote sensing survey and assessment for the renewable natural resource and the ecological environment is adopted, namely the technique superiority of the CBERS-1 should be fully developed and its applied potentiality must also tapped at the most. Based on the latest information of the aero -space remote sensing and through the GPS technique for a spot verification as well as the additional information, and further in combination of GIS technical processing and information analysis, the applied research and the applied demonstration of location, qualitative and quantitative analysis were launched.
The major technical links of the overall technical scenario of the project are shown as below:



General Technical Flow Chart of the Project

3.2 The Applied Research and Demonstration Targets of the Project

1) To conduct the research on the optimizing image processing methodology concerning the CBERS-1 data, it is aimed at to fully develop the latent capability of its information which would be applied for monitoring and assessment, ecological building of the desertification area so as to provide the new information sources of remote sensing for resource and environmental dynamic analysis in the western development of China.
2) Summarizing the applied technical methodology, including image processing, thematic interpretation and mapping, analysis and assessment, results and thereby to create a favorable condition for the application and extension of the CBERS-1 data in the related fields to the forestry.

3.3 Arrangement of Subproject and Monographic Application Tasks

The project has been decomposed into two subprojects and six monographic application tasks.

3.3.1 Decomposition of Subproject

Subproject 1. To study and assess image processing and the applied technical methodology of CBERS-1 data It is aimed at to conduct a study series of data processing technique of various images involving in the different sensors of earth observation (CCD camera, Infrared multi spectrum scanner - IRMSS) of the CNBERS-1. The study should be geared to the needs of thematic application (pre-processing, atmosphere and geometric correction, enhancement, composition of waveband, information abstracting etc.). Also, it is aimed at to conduct some research and assessment of the comparative analysis and image merging with other aerospace remote sensing information source.
Subproject 2. The monographic applied demonstration tasks of CBERS-1 data
It is aimed at to conduct the comprehensive applied study and survey concerning various monographic contents of remote sensing application in each demonstration area and provide analyzing chart and report including the change of land use, the land sandification and ecological environment problems caused by the natural factor or human activities, the treatment benefit of ecological building etc. so as to contribute advice for the Great Western Development Initiative.

3.3.2 Arrangement of Monographic Demonstration Tasks

Task 1. Remote Sensing Applied Demonstration of the CBERS-1 in the Ecological Environment of Oasis and Ecological Building in Fukang City, Xingjiang Autonomous Region;
Task 2. Remote Sensing Applied Demonstration of the CBERS-1 in the Ecological Environment and Ecological Building of Qinghaihu Lake and Gonghe Basin , Qinghai Province;
Task 3. Remote Sensing Applied Demonstration of the CBERS-1 in Land Desertification and Control of Dulan County, Qinghai Province;
Task 4. Remote Sensing Applied Demonstration of the CBERS-1 in the Ecological Protection and Building of Gulang county, Gansu Province;
Task 5. Remote Sensing Applied Demonstration of the CBERS-1 in the Oasis Ecological Environment and Ecological building of Jinta County, Gansu Province;
Task 6. Remote Sensing Applied Demonstration of the CBERS-1 in the Ecological Environment and Ecological Building of Hunshandake Sandy Land, Inner Mongolia Autonomous Region.

3.4 Major Technique Specifications

In unifying the technique requirements, it has prepared the "Major Technique Specification for the Project Implementation". The Specification clearly stated the applied demonstration work, technical indicators and the applied results need to be completed, for every monographic applied demonstration.

3.4.1 The Status and Dynamic of Desertification Within the demonstration area, it will identify the type of land use, the type of land desertification (sandification) and the degree of desertification.
1) The land use type: Farmland, Forestry land, Grassland, land of residents, factory, mines and for communication use, water body, the land unutilized;
2) Type of desertification: Based on the major natural cause, it is usually divided into three type of wind erosion, water erosion and salinization.
3) Degree of desertification: it is usually divided into four grades: light, moderate, heavy and extreme heavy.
4). The type of sandification land: within the type of sandy desertification by wind erosion, it will further mince the type of sandification land.

3.4.2 Assessment of Ecological Environment and Ecological Building

1) Land use type (same to 3.4.1- 1))

2) Type of forestry land: Under the type of forestry land in the land use type, it may further divide different types of forestry land and the forest type.

? Type of forestry land: forested land, lightly stocked land, shrubbery, under-established plantation and others of forestry land etc.

? Type of forest: It may divided by category of forest, origin, dominant tree species and dominant tree species group and the canopy density.

3) Type of grassland

The grassland is an important component of the terrestrial eco-system. Especially, in the western part of China, the grassland not only promote the development of animal husbandry, but also, it contributed substantially the water and soil conservation, to preserve watershed and maintenance of ecological equilibriu m in a very large range of environment. The grassland under the land use type, it can further divided into different types based on the vegetation coverage, height and origin.

3.5 The Image Pre-processing of the CBERS-1.

The task of image pre -processing of CBERS-1 is at the most trying to restore the properties of the reflecting spectrum of the object and its correct geometric position.

1) Radiation correction. The radiation correction of the second grade data of CBERS-1 is mainly eliminating the stripe and noise.

2) Geometric correction: there are mainly geometric correction and registration.

3) Image enhancement: according to the background of the ground object, owing to the difference of the special information to be collected, the method used will be varied. For example, a large contrast of the data in Qinghaihu Lake Area, the lake area approach to black (gray value is zero) while in the sandy land or exposed sandy land in desertification area, the color present white (the gray value approach 255). Thus, the general enhancement/ stretching effect is not desirable. The method of stretching by segment or by sector should be adopted. Based on the gray value, having the data of the whole landscape divided into several sectors, then to process respectively. At last, all the sectors put together and color matching for the boundaries.

4) Abstracting of the features of the remote sensing image information

The remote sensing image of CBERS-1 CCD data embody a large amount of information, it requires that the collection of the characteristic information should based on the different tasks of resource and environment survey together with the monitoring of the project. Usually, the image processing method of linear transformation, filtering and ratio transformations are commonly adopted. In the forest area, the 1,2,3 waveband of CBERS-1, the vegetation is mostly located in the lower luminance area.. Especially, during the vegetation distributed in the shady slope, the logarithmic transformation should be used to reduce the contrast of high luminance and scaling up the ground object and vegetation of the lower luminance area. On the contrary, the cropland are mostly on the high luminance area, if it is intend to raise the clarity of the cropland, the method of exponential transformation may be used. The segment linear stretching could be adopted for both purposes mentioned above as well.

To abstra ct the information of vegetation, it should keep away with the image data of winter and spring season. For example, on the day of November 8, 1999, since the vegetation information in the Qinghaihu Lake area is less plenty, to protrude the vegetation figure, we have made the process of vegetation index and enhanced transformation mapping, thus the processed image vegetation information had been obviously enhanced. The forested land originally difficult to identify becomes more clear and the boundary of the scope of artificial grassland as well. The density of the cropalso can be differentiated.

5) The application of GPS in image processing

The topographic map of the desert and the area of desertification in northwest China has renewable very slowly, plus short of the clear depot of the ground objects in the Gobi desert and the sandfication areas, to select a proper control depot is much difficult. Since the United States cancel the interference policy of SA, the accuracy of positioning has greatly improved. Through the control depots of high accuracy of positioning and thereby the accuracy of geometric correction has also increased. And on the other hand, through the positioning of GPS, the type of land in the remote sensing image can be precisely identified, thus, the selection of training sampling will be more accurate, and provide a precise position and type for conducting the supervised classification, as a result, the accuracy of classification has been heightened.

3.6 The Result of Applied Demonstration for the Project

The field operation of the project had completed in Aug.-Sept, 2000. The indoor image interpretation, the compile of thematic map and the related thematic content analysis have been submitted the initial result. The applied demonstration research of the infrared multi-spectral data is now ongoing. It is expected that all the work will be completed in the August of 2001. The completion of the following results of the project is expected

1) The result of various images processing of CBERS-1 data;

2) The result of the digitized thematic maps and the attribute data base of the CBERS-1 data application;

3) The resource and environmental statistic table by abstracting data of CBERS-1 application;

4) The monitoring and appraisal report on the forest resource, land desertification, status of wetland, ecological environment and

ecological building of the CBERS-1 data application.

3.7 Extension of the Application Results

Through the monitoring and assessment efforts in the key ecological building area of the western China's desertified region, we had the first adopted the multi-waveband, high resolution resource satellite remote sensing image of our own produced, it had greatly encourage the initiatives and the spirit of endeavor to gain the professional proficiency of the broad scientific and technical personnel.

Through the implementing of the project, we had acquired rich experiences of CBERS-1 data application. And on the other hand, the application of CBERS-1 data, it had substantially reduce the cost of the remote sensing material, thus, it would further promote the application of the satellite remote sensing technique in the forestry sectors. The ecological building in the land desertification region involves a vast area in this country. Every year, it will launch the monitoring efforts and practices the planning, implementing, inspection and acceptance of the ecological building project.

In the implementing of this project, the forest survey, planning and design and the research sectors of the western six provinces (autonomous region) themselves have participated the applied practice of the CBERS-1. In summarizing the applied demonstration technique and the result of the project, it will further extend the application of the CBERS-1 data. It is expected that the China's satellite remote sensing data would play more important role in forestry resource and ecological environment domain.

Four color photos attached:

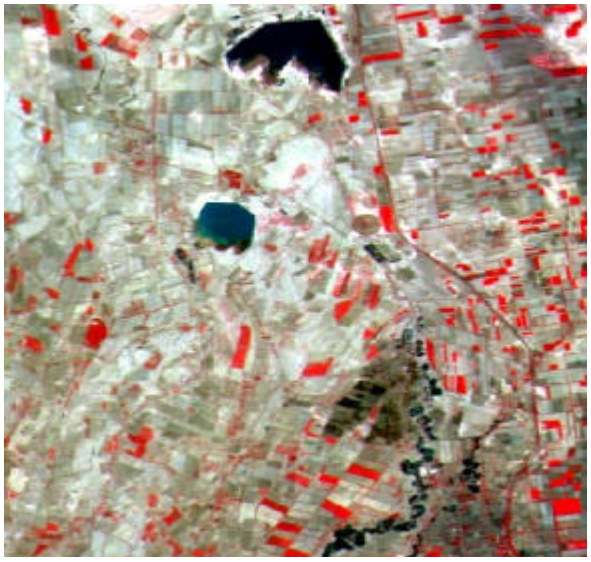


Figure 1 CBERS-1 432 Composed Image of Oasis at Changji, XinJiang
2000.4.29 (P32/R51)

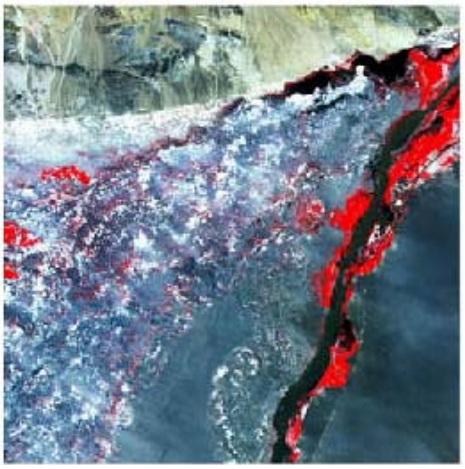
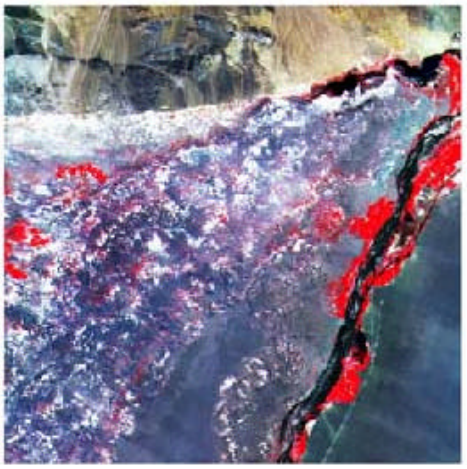


Figure 2 Landsat7 432 Composed Image
2000.6.30(134/32)



CBERS-1 432Composed Image at Jinta,GanShu
2000.7.29 (P19/R55)

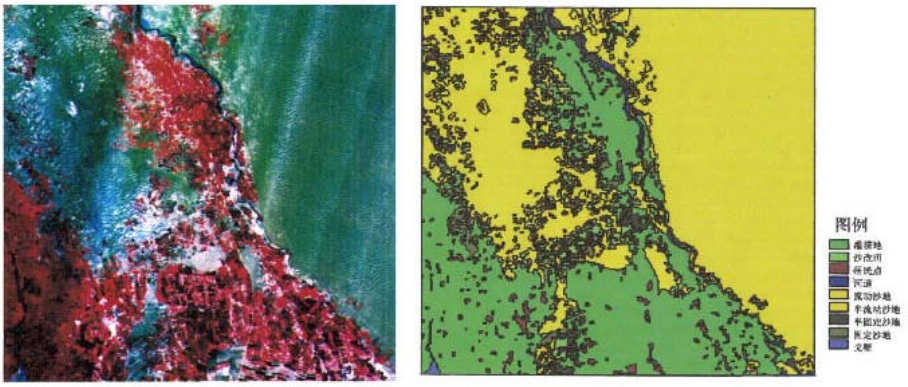


Figure 3 CBERS-1 432 Composed Image and Sandy Land Classification Map of Oasis at Gulang, GanShu 2000.5.1(P14/R58)

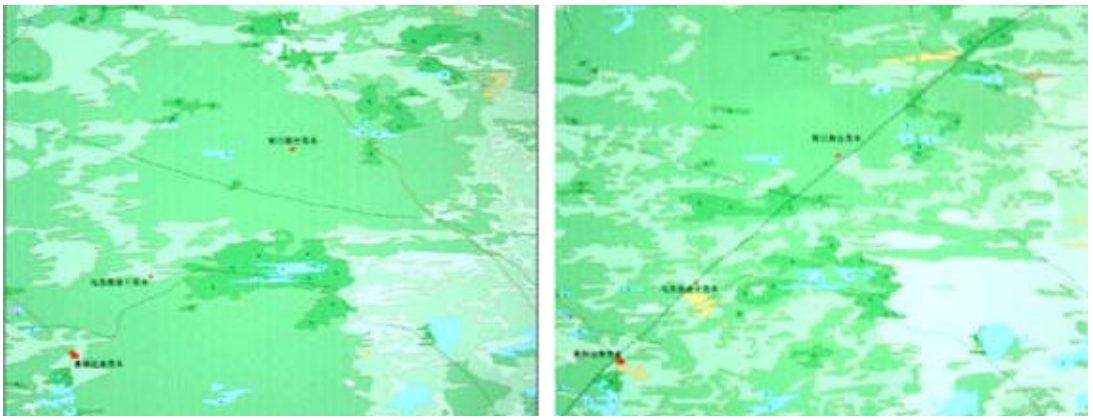


Figure 4 A Land Degradation Analysis case at Hunshandak Sandy Land Area
« 1987(left), TM as information Source; 2000(right), CBERS-1 as information Source»

References:

Liu Jiyuan,1996. China Resource Environment Remote Sensing Macro-Survey and Dynamic Research, China Science and Technology Publishing House, Beijing.

Kenneth . R. Castleman ,1998.(translated by Zhu Zigang etc.), Digital Image Processing ,Electronic Industry Publishing House, Beijing.

Zhou Chenghu etc.,1999. Remote Sensing Image Geo-science Understanding and analysis, Science Press, Beijing.

Zhao Rui etc., 1999. China Environment and Resource Remote Sensing Application, Meteorological Press, Beijing.