Domestic Resource Satellite - Based National Land-use Macro Monitoring

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Key words: Domestic resources satellite, remote sensing technology, land use, macro monitoring, independent research

SUMMARY

This paper systematically reviews the research and development of domestic resource satellites since 1999 in China. Our resource satellite industry research started from scratch and has made gratifying progress in implementation of the national land-use macro monitoring through domestic resource satellite data, and a series of key technology research and monitoring results based on the domestic satellite remote sensing data. On the one hand, the domestic satellite plays an important role in the land and resource management, and also plays an irreplaceable role, in reversing the passive situation completely dependent on foreign satellite data for land resources survey and remote sensing monitoring. It also makes the full cover monitoring to become a reality and to provide data security for the national land use macro monitoring. On the other hand, It is helpful to improve the land and resource management operating system and the construction of "heaven watch, ground monitoring and online management". It also promotes both the micro and macro monitoring. Timely monitoring results reflects the overall condition of the land use change in the country and the typical regional monitoring helps not only for macro-management monitoring the basic data, but also provides further inputs like lock "point" goal and orientation "target area" monitoring basis. Therefore, the macro monitoring gives a solid foundation for promoting domestic resource satellite service applications and to raise the level of land and resource management to provide a strong and effective technical support.

论文摘要：
本文较为系统地回顾了我国自 1999 年以来自主研制国产资源卫星的发展历程，由此看到我国资源卫星产业发展已迈出了从无到有的第一步并取得可喜进步，虽起步晚，但起点高。通过以国产资源卫星为数据源成功实施全国土地利用宏观监测为例，详细介绍了基于国产卫星遥感数据所开展的系列关键技术研究成果以及监测成果。一方面，显示出国产卫星在国土资源管理中正在扮演着重要角色，并发挥着不可替代的作用，不仅逐步扭转了完全依赖国外卫星数据开展土地资源调查与遥感监测的被动局面，更使全国全覆盖监测成为现实，为全国土地利用宏观监测提供了数据源保障。另一方面，反映出宏观监测更加有助于完善国土资源管理运行体系“天上看、地上差、网上管”的建设，促进微观监测与宏观监测形成有利互补。其监测结果能及时反映出在全国及典型区域上监测出土地利用及其变化的总体状况，不仅为国土资源宏观管理提供了监测基础数据，更为进一步发现和锁定“点上”目标提供了定向“靶区”监测依据。因此，宏观监测为促进国产资源卫星业务化应用奠定了坚实基础，并为提高国土资源管理水平提供了有效的技术支撑。
关键字：国产资源卫星，遥感技术，土地利用，宏观监测，自主研制

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1. INTRODUCTION

From 1999 to 2009, China implemented a new round of land and resource survey project, one of them is land use dynamic monitoring by remote sensing project. Project with "3s" technology as the foundation, combining with the ground survey and computer network communication and other modern means of science and technology, in the use of the land within the specified period resource and land use changes in remote sensing monitoring[1]. The data source often mainly used high-resolution remote sensing data such as the United States (Landsat, IKONOS, QB), France (SPOT), India (IRS). On the one hand, with continuous dynamic monitoring for multi-source, multi-temporal, multi-resolution satellite remote sensing data is an urgent demand, continuously to improve the quantity, quality, and resolution; On the other hand, with the increase of monitoring the city and expansion of the scope, the country annually funds for the purchase of the massive foreign satellite data is also increasing. Nevertheless, due to various reasons it is difficult to receive remote sensing data in some regions of China, which has resulted in not achieving full coverage of nationwide monitoring.

Despite the late start of our resource satellite development, it has made great progress and improvement by achieving the rapid development as in the past decade foreign satellite remote sensing technology from 1999, has successfully launched a series of Resource Satellites (CBERS-01/02/02B, ZY1-02C), resources III (ZY-3) , Beijing-1 small satellite (BJ-1) as well as the environment I satellite (HJ-1A / B). With the successful launch of high-resolution satellites in orbit, China has gradually reversed the passive situation of over-reliance on foreign satellite data. It makes the choice of using both remote sensing data at home and abroad, so that the field of remote sensing technology applications becomes broader, and optitum use of domestic satellite data of land-use macro-monitoring is implemented.

This paper systematically reviewes the course of resources satellites development of China, through the domestic based satellite data of land use macro-monitoring implementation, and details of a series of key technology research carried out by a domestic satellite-based remote sensing data as well as monitoring results. Successful implementation of macro monitoring clearly shows the domestic satellite data will play an important role in land and resource management. For the domestic satellite data service applications laid the technical foundation and provide technical support to further improve the efficiency, effectiveness, and efficiency of domestic resources satellite applications.

2. EARTH RESOURCE SATELLITE DEVELOPMENT REVIEW

The goal of Earth resource satellite as the most important remote sensing detectors is very clear for earth resources and environment detection of satellite[2]. Earth resource satellites can quickly and effectively provide the relevant information of the status quo of the earth resources. With the emergence of the resource satellite as well as the use of remote sensing technology, fundamentally change the methods and means of human observations of the Earth.

2.1 Introduction of foreign land resource satellite development

The first Earth resource satellite of the world was launched on July, 1972 by U.S.A. The extensive use of the satellite remote sensing information made people realize the importance of resource satellite search, development, utilization and management of earth resources as a very effective tool, so many countries tried to developed their own earth resource satellites. The most typical and commonly used are U.S. Landsat, French SPOT, JERS of Japan, the European Community the ERS, Radarsat Canada, India IRS[2].

2.2 Development Review of the Domestic Earth Resource Satellite

Earth resource satellite has gone through three main stages of development in China. The first phase from 1970s to the early 1980s, mainly by learning to explore, research study, technical imitation and build the team; the second phase gradually enter of the experiments and preliminary application from 1980; Next the third stage since the 1990s, mainly to the widely used[3]. Domestic resources satellite, as the representative of the CBERS satellite series (including CBERS-01/02/02B、ZY1-02C), ZY-3, Beijing-1 small satellite (BJ-1) and environmental satellite series (HJ-1A/1B).

2.2.1 China-Brazil Earth Resources Satellite

The China-Brazil Earth Resources Satellite (**CBERS**) is a real-time transmission type of earth observation remote sensing satellite, it can sent visible light, multi-spectral remote sensing image information to China, Brazil and the rest of the world with the receiving ability of both national and regional. It has been widely used in crop yield estimation, environmental protection and monitoring, urban planning and land and resources survey and investigation, which has played a very important role in the economic and social development in different countries[4]. China's first Earth resource satellite was successfully launched in Taiyuan thus ending the history of China not having own .land resources remote sensing satellite. Ultimately it developed real-time satellite remote sensing data, which is more representative of the level of China's satellite development to a new level[5]、[6].

CBERS-01 satellite (CBERS-01) was successfully launched on October 14, 1999 in Taiyuan, which remained in orbit for 3 years and 10 months. CBERS-01 was developed in cooperation with Brazil as China's first generation transmission type of Earth resources satellite[7]. It was hailed as "a model of the South-South cooperation[8].

CBERS-02 satellite (CBERS-02) was successfully launched on October 21, 2003, which

remained in orbit for five years and three months, far beyond the two-year design life. Second satellite had the longest life expectancy in China's low orbit Remote Sensing Satellite[9]. The satellite technical characteristics of the 02 satellite and 01 are basically the same, but Optimized design 02 satellites in orbit, the satellite has been greatly improved in quality and reliability to ensure the continuity and consistency of our resource remote sensing satellite data .for sustained stability which is of great significance for remote sensing applications; and at the same time, it also increased the international market satellite remote sensing data resources[10].

CBERS 02B satellite (CBERS-02B) is the third satellite of the system, It was successfully launched on September 19, 2007 and remained in orbit for only 1 year and 8 months and didn't have normal operation from May 2009. 02B satellite is the first one for a wide range of industries to provide high spatial resolution satellite image data in China, it has a high load resources and low resolution of great significance for ensuring that the CBERS satellite system has long-term stable operation satellite at the same time[8]. Its launch promoted international cooperation in the field of aerospace. It will play an extremely important role in development and production follow-up CBERS satellite[4]. The subsequent satellite 03 and 04 are being developed, it is understood that the 03 satellite launch time has been initially identified in 2014. In addition, China and Pakistan are also carrying out pre- work of -05/06 satellite[8].

China has independently developed civilian one wide band, high spatial resolution remote sensing satellite CBERS-02C[15]. It was successfully launched at the Taiyuan Satellite Launch Center on December 22, 2011, which can be widely used in land use dynamic monitoring of land use change survey, development of mineral resources protection and utilization of survey and monitoring of geological disasters, ecological and geological environment survey, disaster prevention and mitigation, disaster assessment, urban and rural planning and construction and other related industries. Ministry of Land implemented under the auspices of resources satellite not only to fill the high-resolution remote sensing data gaps, but also greatly ease the domestic high-resolution remote sensing data out of stock issues, Also greatly ease the problems of domestic high-resolution remote sensing data is interrupted, It can significantly improve the land resources survey and monitoring level, effective support resource environmental remote sensing survey and monitoring business operations.

2.2.2 ZY-3 satellite

The ZiYuan-3 (ZY-3) is the first of a new series of high-resolution civilian stereo mapping satellites, which was launched on January 9, 2012 in Taiyuan. The main task is long-term, continuous, stable, fast access to a nationwide high-resolution three-dimensional images and multispectral images. It has a designed life expectancy of five years[11]. The ZY-3 satellite fills the gaps in China's civilian mapping satellites and serves as a milestone in enhancing China's independent access to high-resolution geospatial information and resolving the strategic shortage of fundamental geographic information resources. It will reverse the situation of the civil space stereo mapping business depends on the situation of foreign remote sensing data, and to promote the level of surveying and mapping services in China. The successful launch

is an important symbol of our mapping geographic information equipment level substantive leap, and it is a milestone of the maintenance national geographic information, spatial information security. It is reported that it will be launch 02, 03, 04 follow satellite behind ZY-3. It is similar with ZY-3 in the accuracy and already comparable with the SPOT satellite[16].

2.2.3 Beijing-1 small satellites

Beijing-1 small satellite was developed and launched on October, 2005 by SSTL (Surrey Satellite Technology Limited), which was handed over to China's national ministry of science and technology and Beijing municipal government and another two departments. Now the BJ-1 small satellite runs orderly. The satellite is a high-resolution earth observation satellite, two type of sensors were carried on the satellite. Its excellent performance of wide coverage and high revisit to some extent alleviated the urgent need for high-resolution remote sensing images, and the products are distributed to many users from land use change survey, surveying and mapping, agriculture management, and monitoring of geological disasters, etc. al fields [12].

2.2.4 HJ -1 satellites

HJ-1 series satellites are mainly used for environment and disaster monitoring in China. The HJ-1A and -1B satellite has been launched on September 2008. The lifespan on orbit is 3 years. Due to the high temporal resolution, macroscopic properties and multi-scale have broad application prospects in large-scale, all-weather, all-time environment and disaster monitoring and evaluation[13]. HJ-1C is the first SAR sensor, and will be launched in 2012. It will with HJ-1A and HJ-1B formed the "2 + 1" constellation, initially formed on monitoring capabilities for our environment and disaster[14].

3. LAND USE MACRO-MONITORING

3.1 Goals and Tasks

The overall goal of macro monitoring is carried out based on the domestic resources satellite data source for the land use macro monitoring, mainly querying the existing domestic resolution multi-spectral data of CBERS, HJ-1A / B and BJ-1, to achieve at least 1 time per year full coverage nationwide land-use change monitoring and every 2-3 years once current land use remote sensing monitoring. Domestic resources satellite service applications, independently developed satellites to get a wider range and depth of application in the field of land management. Other applications are perfecting Land Use Dynamic Monitoring System, the formation of macro and micro monitoring complementary relationship, to participate in the decision-making of economic macro-control which has great potential for land management and land resources, accurate, comprehensive basic data.
The general task is to carry out new construction land-based land-use macro monitoring annually, macro grasp the total land use change and quickly master the annual land use trends, to provide a "target" for national land use dynamic remote sensing monitoring and land regulation. To carry out more than 500,000 population urban scale expansion monitoring,

grasps the expansion trend of key city. Providing the basic data for land and resource management and macro-decision making; According to department needs to carry out timely emergency monitoring, and continue to promote the domestic resources satellite land business application and demonstration, and to provide technical support for domestic resources satellite service applications.

3.2 Domestic satellite data sources

The implementation of land-use macro monitoring in 2009 with regard to the (BJ-1) Beijing-1 small satellite multispectral image as the main data source, it selected the two images 2007.09-2008.01 and 2008.09-2009.01. When BJ-1 remote sensing images could not satisfy the coverage conditions, it was supplemented by (CBERS-02B) image data. The domestic satellite data acquisition and the situation of provinces cover is shown in Table 3-1. BJ-1 multis-pectral data covering more than 17million square kilometers and more than 200million square kilometers covered by CBERS-02B multi-spectral data.

Table 3-1 domestic satellite data acquisition and provincial coverage summary

time phase	Domestic satellite	beijing	tianjin	hebei	shanxi	neimeng	liaoning	jilin	heilongjiang	shanghai	jiangsu	zhejiang	anhui	fujian	jiangxi	shandong	henan	hubei	hunan	guangdong	guangxi	hainan	chongqing	sichuan	guizhou	yunnan	xizang	shanxi	gansu	qinghai	ningxia	xinjiang
2007.9 -2008.1	BJ-1	√	√	√	√	√	√	√					√	√	√	√	√	√	√	√	√		√	√	√		√	√	√	√	√	√
	CBERS-02B								√	√	√	√										√				√						
2008.9 -2009.1	BJ-1	√	√	√	√		√	√		√	√	√		√	√	√	√	√	√	√	√	√	√		√	√	√	√		√	√	√
	CBERS-02B					√			√				√											√					√			

3.3 Key Technology Research and results

Macro monitoring key technologies research mainly relies on some important projects. Such as the Ministry of Land and Resources of special - a new round of survey "land use dynamic remote sensing monitoring "(1999-2009), the second national land survey (2007-2010),
Especially COSTIND research thematic projects - domestic resources satellite remote sensing data of land use large-scale applications. Ministry of Land and Resources nonprofit industry research thematic projects- experimental study of land use macro-monitoring application based on domestic satellite, national satellite application technology industry thematic projects-based on the domestic satellite data land use macro monitoring demonstration project. As well as a number of key engineering and research topics - domestic resources satellite macro monitoring key technical pre-research, domestic resources satellite in medium and low resolution is the orthophoto map production and land use change information extraction. Obtained the result of land use macro monitoring key technology research has laid a solid technical foundation to improve the automation level of domestic satellite data of land use macroscopic monitoring and to further build the macro-monitoring business application system based on the domestic satellite data.
The achievements of key technology research including macro-monitoring domestic satellite coverage analysis and coverage program, macroeconomic monitoring the domestic satellite data characteristics analysis and the data pretreatment technology, satellite remote sensing

imagery produced imaging products quality control techniques, the land use information quickly extract and classification accuracy evaluation techniques, land-use change information quickly extract and accuracy of evaluation techniques, the macro of monitoring outcomes storage and management technology, Basically completed parallel processing of land use macro-monitoring and collaboration prototype system development and macro-monitoring data management system development, as well as the completion of a series prepared “standard of macro monitoring technical requirements based on domestic satellite data ", involving four technical provisions “land use macroeconomic monitoring and data processing technology standard" (relate to “macro monitoring of land use information extraction technology standards “(see Table 3-1), “land use macro monitoring results of standard” and “ based on domestic resources satellite data of land use macro monitoring”).

Guangdong Province BJ-1 image Guangzhou City BJ-1 image

Fig. 3-1 Provincial, municipal ortho remote-sensing images

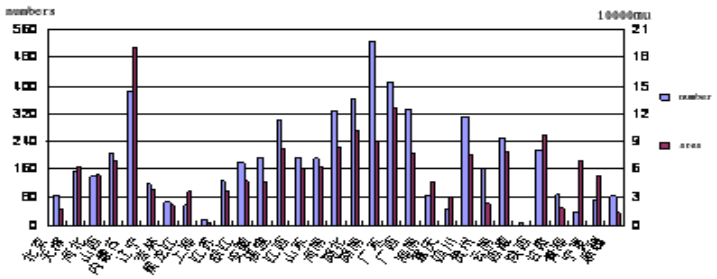

Fig. 3-2a Provinces of additional construction land number and area statistic (2007-2008)

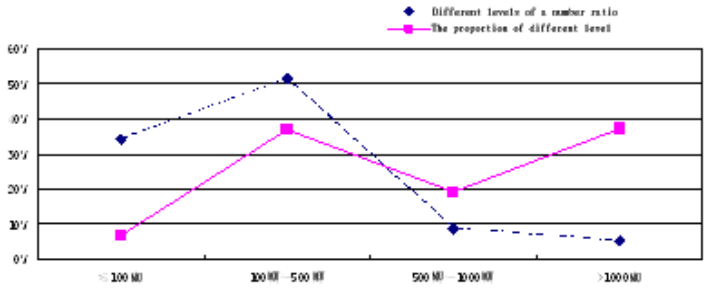

Fig. 3-2b New construction land area classification and distribution characteristics (2007-2008)

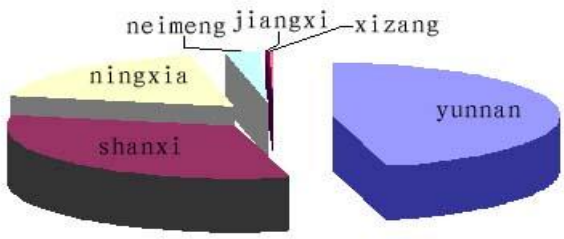

Fig. 3-2c New airport land area and distribution statistical chart (2007-2008)

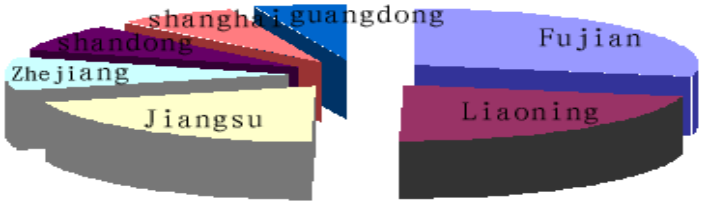

Fig. 3-2d New port area and distribution statistical chart (2007-2008)

Macroscopic monitoring results are rich in content. After experiencing domestic resources satellite data source selection, remote sensing data acquisition, the orthophoto map production technical process, orthophoto map products (including the national, provincial and city, see Fig. 3-1), based on the base map to complete the macro-monitoring information extraction. Specific monitoring results include: national new construction land situation from 2007 to 2008, involving new construction land, the new airport site, the new port terminal space, new land for road use, and monitoring of the National Golf Course. And on this basis, to carry out a statistical analysis of the macro-monitoring results, involving the overall size of new construction land, new airport site statistics, new land for port statistics, new road use statistics, new construction with ground Points analysis of the contents of level, new construction land area distribution and land for golf courses, etc., see Fig. 3-2a-d.

4. CONCLUSION

Through the implementation of the land-use macro monitoring, domestic resources satellite will play an increasingly important role in land and resource management. It will comprehensively study the Beijing-1 small satellite, China and Pakistan, the domestic environment the 1st resolution satellite data coverage ability, to understand the ability to support domestic resources satellite land use macroeconomic monitoring data and data source support capabilities. It will also analysis data coverage ability of the Beijing-1 small satellite, CZCS, HJ-1, to understand the ability to support domestic resources satellite land use macro monitoring data and data source support capabilities.

Macro-monitoring based on the domestic satellite data of key technology research and technical standards development to provide effective technical support and guarantee the

successful implementation of macro monitoring land use. The domestic resources satellite industry has laid a solid foundation for applications, as well as to promote the construction and improvement of the macro-monitoring system.

It can quickly get to the national or regional land use trends through the macro- monitoring. The results of Macro monitoring provide services for the macroeconomic analysis and change "target" for micro-monitoring which can quickly find regional change with microscopic monitoring complementary. From the macro and micro levels, timely enactment of the national macro-control policies and land regulatory measures provide the basis for dynamic remote sensing monitoring system to improve the national land use.
With the continued development and growth of the satellite industry of China, as well as increasing levels of remote sensing technology, There will be more independently developed domestic satellite which will give more choices in remote sensing data and applied macroeconomic monitoring, resulting in more monitoring results with wide-ranging and in-depth land and resources management.

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BIOGRAPHICAL NOTES

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Education:
From 2002 to 2004, studied in the Department of Geoinformatics, ITC, Netherlands
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From 2004 to up now, work in the China Land Survey and Planning Institute, Ministry of Land and Resources (MLR)
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Since 1983, the work from the beginning, Ms. He Yuhua has been engaged in the research and application of survey mapping, GIS and remote sensing in the fields of Geological, environmental and land resources management and so on. There are more than 30 papers in the core journals published in Chinese including some of them in the Proceedings (e.g. SPIE) in English, of which six papers can be retrieved by SCI or EI. In 2010, Ms. He presented in Marrakech, Morocco held at the FIG conference, presenting a thesis and oral presentation.

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