A System Development for Remote Sensing, and Interpretation for Rice Fields in the World Using Satellite Data

JIFS, 4 : 93 - 99 (2007) original paper

A System Development for Remote Sensing, and Interpretation for Rice Fields in the World Using Satellite Data

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Keywords: Remote Sensing, System development, ASTER, Rice Fields, GIS

Received 10 January 2007; accepted 5 February 2007

Abstract

Remote Sensing Laboratory, Field Science Center, Graduate School of Agriculture Science, Tohoku University started at April 2004. For the studies and education at the laboratory we are now developing the system of remote sensing and GIS. Our system consists of ordinary PCs, one digitizer and one color laser printer. The PCs are assembled by us for the optimal performance and the low cost. Gigabit LAN connects each PC, and one PC is used as file server to store remote sensing images and GIS data such as digital maps, geocoded satellite images and digital elevation models (DEM). The file server has RAID system for safety storage from HD trouble. We use ARC/GIS as GIS software and many kinds of Remote Sensing software such as, ERDAS/Imagine, ENVI, eCognition, PG-Steamer and SILCAST. Using the developing system, we understand and teach for regional differences of agriculture especially with the interpretation of ASTER data analysis.

A kind of project "Determination of Local Characteristics at Global Agriculture Using archive ASTER Data" was started at the middle of November 2005. We establish data processing system and get some results. Paddy rice fields analysis was started at first, we analyze 1) the Shonai Plains in Japan, 2) the Yangtze River delta in Middle-East China, 3) Mekong Delta in South Vietnam, 4) North-east Thai Plaines, Thailand, 5) Sacrament Valley, California, USA.

The results of this studies are as follows, 1) Using ASTER images, we can easily understand agricultural characteristics of each local area. 2) ASTER data have high accuracy for location, and the accuracy is suitable for global study without the fine topographical maps, 3) By five years observation of ASTER, there are huge numbers of ASTER scenes, but not enough volumes for cloud free data for seasonal analysis. It means that follow-on program of ASTER is necessary, 4) We need not only paddy field, but also all crop fields and all area, 5) The studies are necessary to international corroboration.

1. Introduction

Recently, the importance of terrestrial and marine field sciences might be realized in many courtiers including Japan, and remote sensing and GIS are powerful tools for the study[1,2]. For this reason, Remote Sensing Laboratory, Field Science Center, Graduate School of Agriculture Science, Tohoku University in Japan started at April 2004, and at the time, there was nothing about Remote Sensing and Geographical Information System (GIS) tools. First, we developed analytical system for the remote sensing and GIS using hand made PCs at the lowest cost.

In 1983, Dr. Joji Iisaka etc. published the beautiful color book named "World Agricultural Surveyed from Space"[3] using Landsat/MSS images. Unfortunately it was written in Japanese, if it had been written in English, it would be the famous book in the world. More than 20 years from the publication, we hope to renew the book using Terra/ASTER data. We used archive ASTER data and analyzed the data for the purpose.

2. Developments of Remove Sensing System Using GIS

For studies and educations at the laboratory, we developed the system of remote sensing and GIS. Our system consists of hand made PCs, one digitizer,

one color laser printer and one scanner, and outline is listed Fig. 1. We assemble the PCs for the optimal performance and the lowest cost. A gigabit LAN connects each PC, and one PC is used for file server to store common data such as maps, remote sensing images, and GIS data. The file server has RAID system for safety storage from HD trouble. Main-use software is ArcGIS and ERDAS/Imagine and we use them jointly with floating licenses. Multi-Spec, eCognition, PG-Steamer of remote sensing software were already installed on some PCs and we hope some more software such as ENVI and ER-Mapper will be installed.

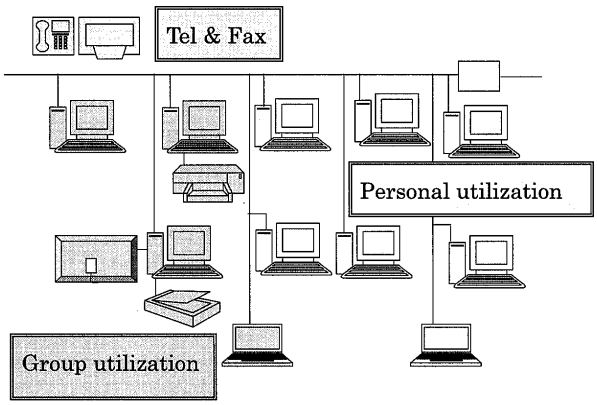

Fig. 1 Developing system of Remote Sensing Laboratory, Field Science Center, Graduate School of Agriculture Science, Tohoku University

Our System has seven desktop PCs and two laptop PCs that are connected to Gigabit LAN using Hub in our room and 100-mega bps LAN to outside. Each desktop PC has 1.8-2.8 GHz CPU, 1-2 GB random access memory, high performance graphic board, and 100-400 GB hard disk. Our laboratory has two staffs, eight students, and some visitor scientists and/or students. Four desktop PCs were almost personal use; and these PCs can use Erdas/Imagine and ARC/GIS by floating license system. One desktop PC is a data server using RAID system and two desktop PCs for the use of more difficult analysis of remote sensing and GIS with high level performance and special analysis software, and manages the floating license.

3. Image Interpretation of Archive ASTER Data

3.1. Characteristics of ASTER data and Procedures

To elucidate the mechanism of climate change in particular, which is the one of the most profound concern among the changes foresaid, NASA promotes Earth Observing System Project (EOS Project) where systems has been/will be developed for observing the Earth from space by satellites and of data processing and various research programs for data application has been/will be conducted. 24 sensors including ASTER are planned as part of instruments for use in the EOS Project. The features of ASTER Sensor are, high spatial and radiometric resolution, broad spectral coverage (visible- through thermal-infrared), and stereo capability on a single path[4].

We want to more precision understanding of the local characteristics using ASTER data. First we check the advantages of ASTER data, and the results are as follows,

1. High-resolution and the large swath
2. Large wavelength and many bands
3. High-revel of geographical location
4. Stereo pair images
5. High performance data searching system
6. High speed data delivery system
7. Cheap price
8. Large volume archive by seven years observation

A kind of project "Determination of Local Characteristics at Global Agriculture Using Archive ASTER Data" was started at the middle of November 2005. We establish data processing system and get some results. The procedure is listed in Fig. 3. At first, we survey target and request the data at level 1A data for analyses using ASTER Ground Data System (GDS). Next, The level 1A data are processed to ortho image of ENVI format with UTM coordination and made to Digital Elevation Model (DEM). At last, we use the data for understanding localities of agriculture using package software such as ENVI, Erdas/Imagine, and PG-Steamer.

Paddy rice fields analysis was started at first, we analyze four areas in Asia and one area in America, as follows;

1) The Shonai Plains in Japan

2) The Yangtze River Delta in Middle-East China
3) North-east Thai Plaines, Thailand
4) Mekong Delta in South Vietnam
5) Sacrament Valley, California, USA

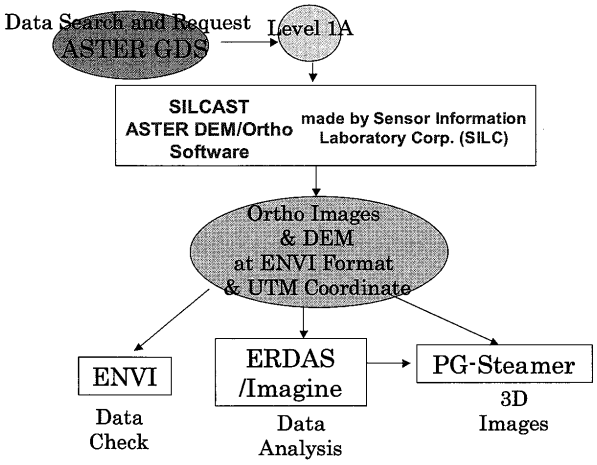

Fig. 2 Data processing procedure and using software

3.2. The Shonai Plains in Japan

The results of the Shonai Plains in Japan are listed in Fig. 3. Shonai district is located in the west side of Yamagata Prefecture and the district faces the Sea of Japan (Fig. 3, upper). There are Mt. Chokai in the north, Dewa mountains in the east and Asahi mountains in the south and Japan sea in the west. In the district, it snows heavily in the winter, and paddy agriculture is widely performed using the water resources. Shonai area is a typical paddy area in Japan (Fig. 3, middle).

Recently, rice has been overproduced in Japan and some parts of rice cultivation fields are changed to other crops. Soybean area is enlarged in the district. Images of Fig. 3 are taken in the end of May, and dark area is rice paddy and bright area is soybean field in lower image. In this area, fields shape is the rectangle and size is large in Japan (Fig. 3, lower).

3.3. The Yangtze River Delta in Middle-East China

The Yangtze River delta in Middle-East China is listed in Fig. 4 and this delta was famous rice production area. Upper left is 3D image, and we can recognize almost flat plain. Only lakeside area is high elevation, and this area is park for recreation. Upper right is closeup image, and we can recognize field shape and size. Paddy field shape is both of the rectangular and irregular. Lower images of Fig. 4 are time series in May, June and July.Dark area at 3 times is fishpond and dark only in June image is paddy rice.

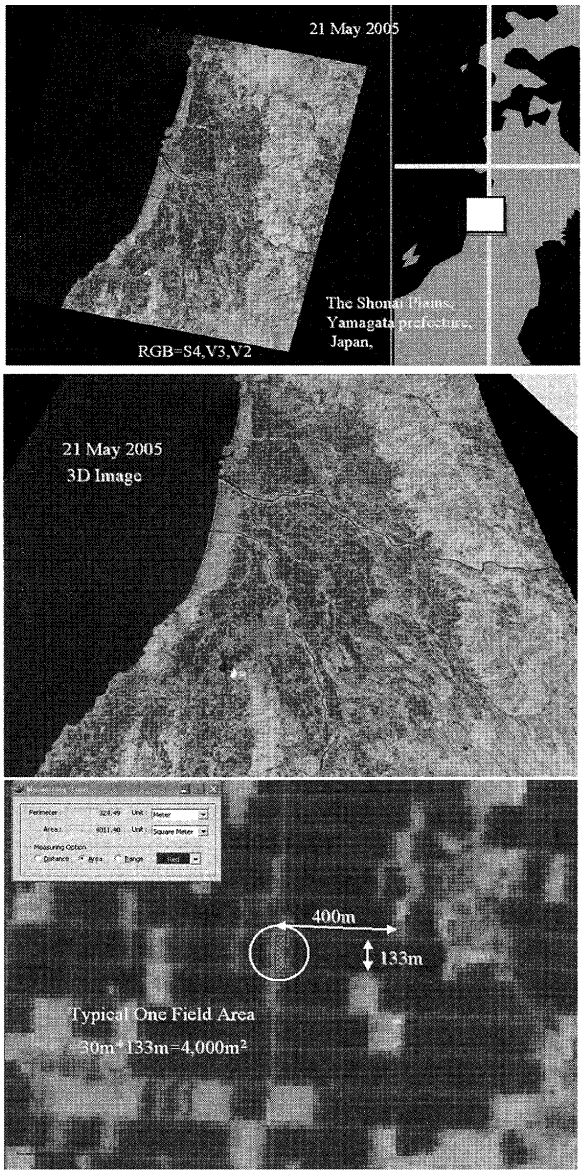

Fig. 3 Paddy fields at the Shonai Plains in Japan
Upper: Total scene of ASTER data and the map of location
Middle: 3D image of the Shonai Plains
Lower: Field size of the Plains

3.4. North-east Thai Plaines, Thailand

Fig. 5 is the image of paddy fields at North-east Thai Plaines, Thailand. In this area, there are paddy fields more than 50% in Thailand. Fig. 5 upper photos are time series images in July, November and January. In this area, rainy season is from April to October, and July and November have vegetation. January is in the middle of dry season, and there are almost no vegetation. Fig. 5 lower left is 3D image and this area is very flat. Fig. 5 lower right is closeup image, and paddy fields are small and irregular.

3.5. Mekong Delta in Vietnam

Images of Fig. 6 are the Mekong Delta in South part of Vietnam. Lower left is the 3D image, and we can understand very flat area. Upper left are 3 times images in November, January and February., Rice crop grow in dry season in the area, because in rain season there are excess water for rice plant. Both two photos of right side are closeup images, and there are very small and very big paddy fields in the area.

3.6. Sacrament Valley, California, USA

Sacrament (Central) Valley, California, USA is listed in Fig. 7. Upper left is total scene and locates on small world map. Upper right are two seasonal images in May and July. Water covers paddy field in May and vegetation as rice body covers the filed.

We can understand the area has mountains in both side and middle in left two images in Fig. 7. Lower right indicates the field size is very large in the area.

3.7 Summarization of each Characteristics

We perform almost same procedure to Yangtze River delta in Middle-East China, Mekong Delta in South Vietnam, and North-east Thai Plaines, Thailand. The results of five areas are listed in Table 1.

The Shonai Plains is typical paddy fields area in Japan, and has well-developed irrigation and drainage systems. The Yangtze River delta in Middle-East

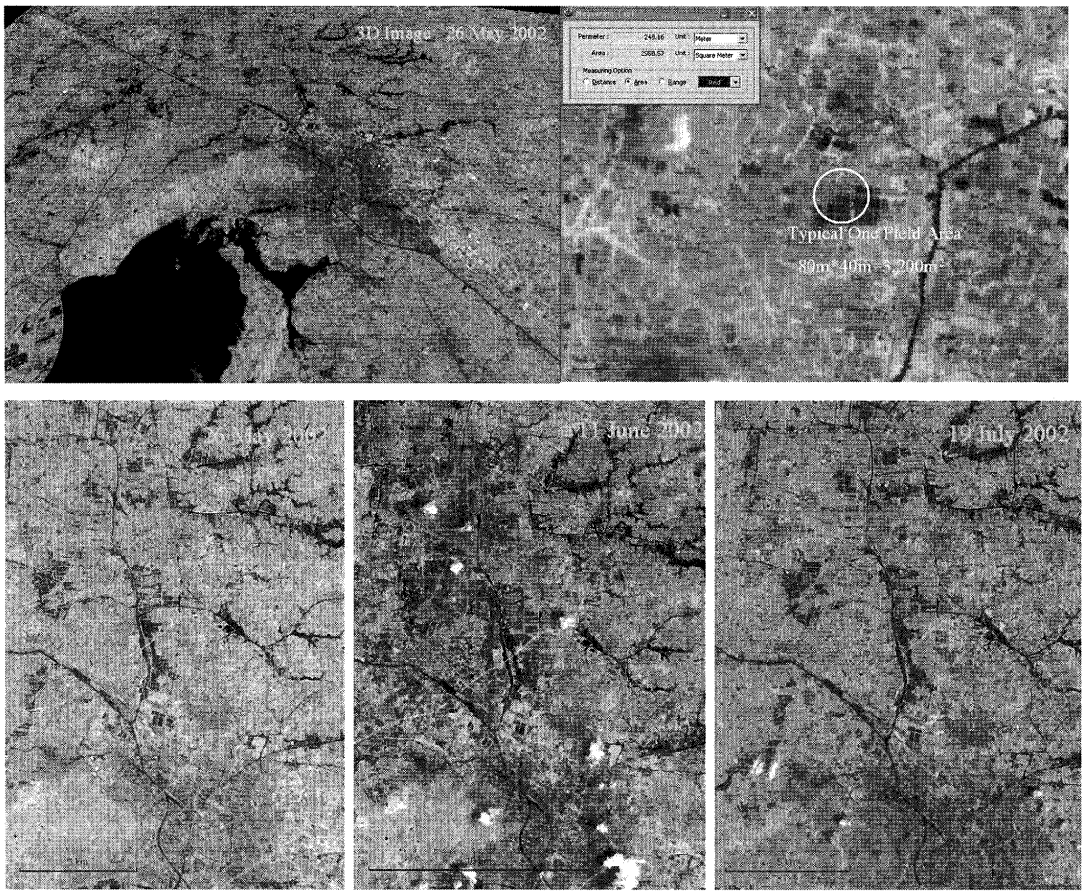

Fig. 4 Paddy fields at the Yangtze River Delta in Middle-East China
Upper left: 3D image of the paddy field. Upper right: Field size of the fields
Lower: The images of in May, June and July

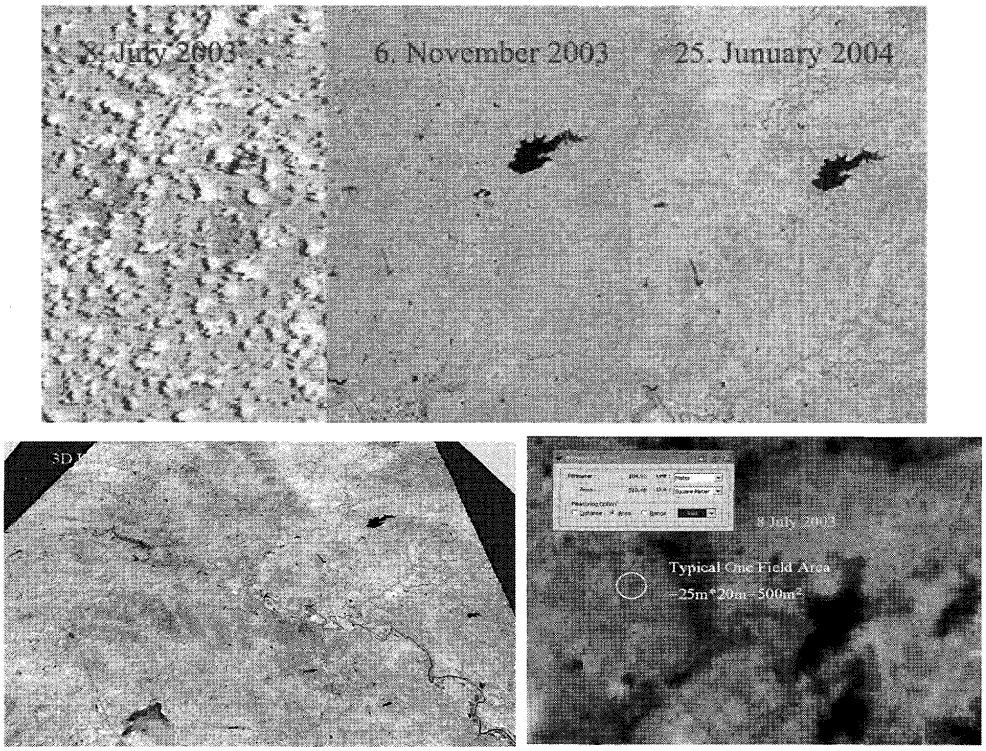

Fig. 5 Paddy fields at North-east Thai Plaines, Thailand
Upper: The images of July, November and January
Lower left: 3D image of the paddy field. Lower right: Field size of the fields

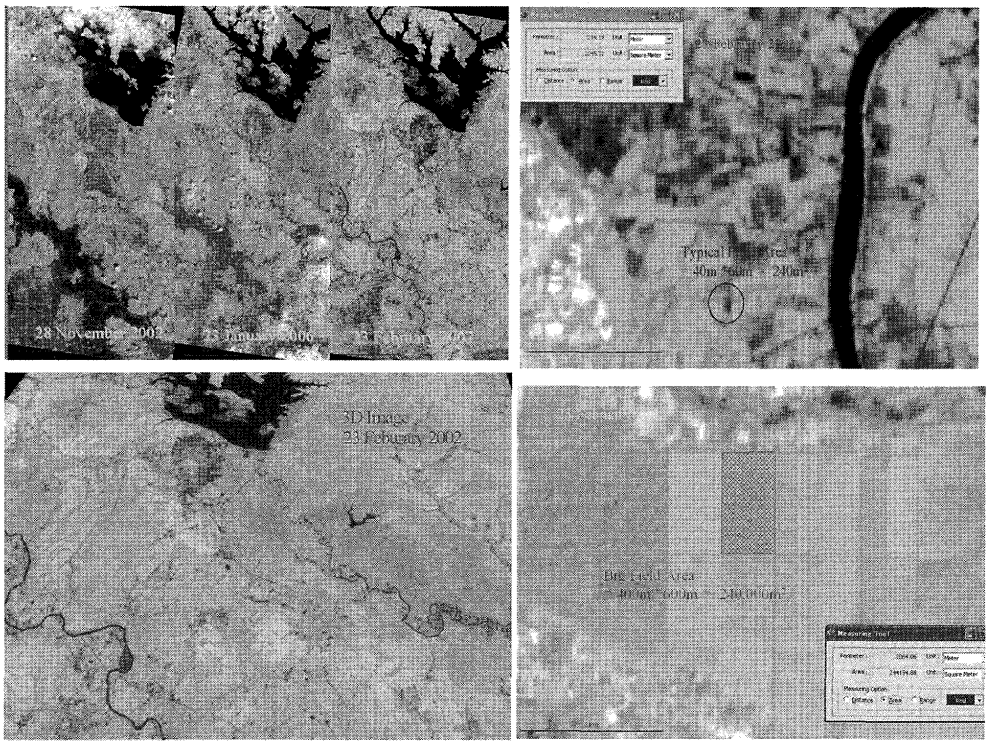

Fig. 6 Paddy fields in the Mekong Delta in South Vietnam
Upper left: The images of in November, January and February. Upper right: Field size of the ordinary fields
Lower left: 3D image of the paddy field. Lower right: Field size of the large fields

Table 1. Characteristics of Each Paddy Field

	Regional Topography	Growing Season	Field Size	Field Shape
Shonai, Japan	Mountainous	Summer	Middle	All Rectangle
MW-China China	Almost Flat	Summer	Middle	Half Irregular Half Rectangle
NE-Thai, Thailand	Very Flat	Rainy	Small	Almost Irregular Same Rectangle
Mekong Delta, Vietnam	Very Flat	Rainy	Mainly Small Minority Large	Rectangle
California USA	Almost Flat	Summer	Large	Almost Rectangle Same Irregular

China is the famous paddy fields area on a global scale. The area of Mekong Delta in South Vietnam and Northeast Thai Plaines are famous to produce exporting rice. At the area, there is enough temperature, but limitation of rice growth is water. Northeast Thai Plaines have severe dry season, and at the season, rice cannot grow. Mekong Delta area is attached to South China Sea and has a big river. At the area, rice grows not only in rainy season but also dry season. Sacrament Valley, California, USA is also very famous commercial rice producing area. At the area each paddy field size is almost ten times larger than Japanese large paddy felid. We can easily understand that it is very difficult to make the rice at same cost in Japan and USA.

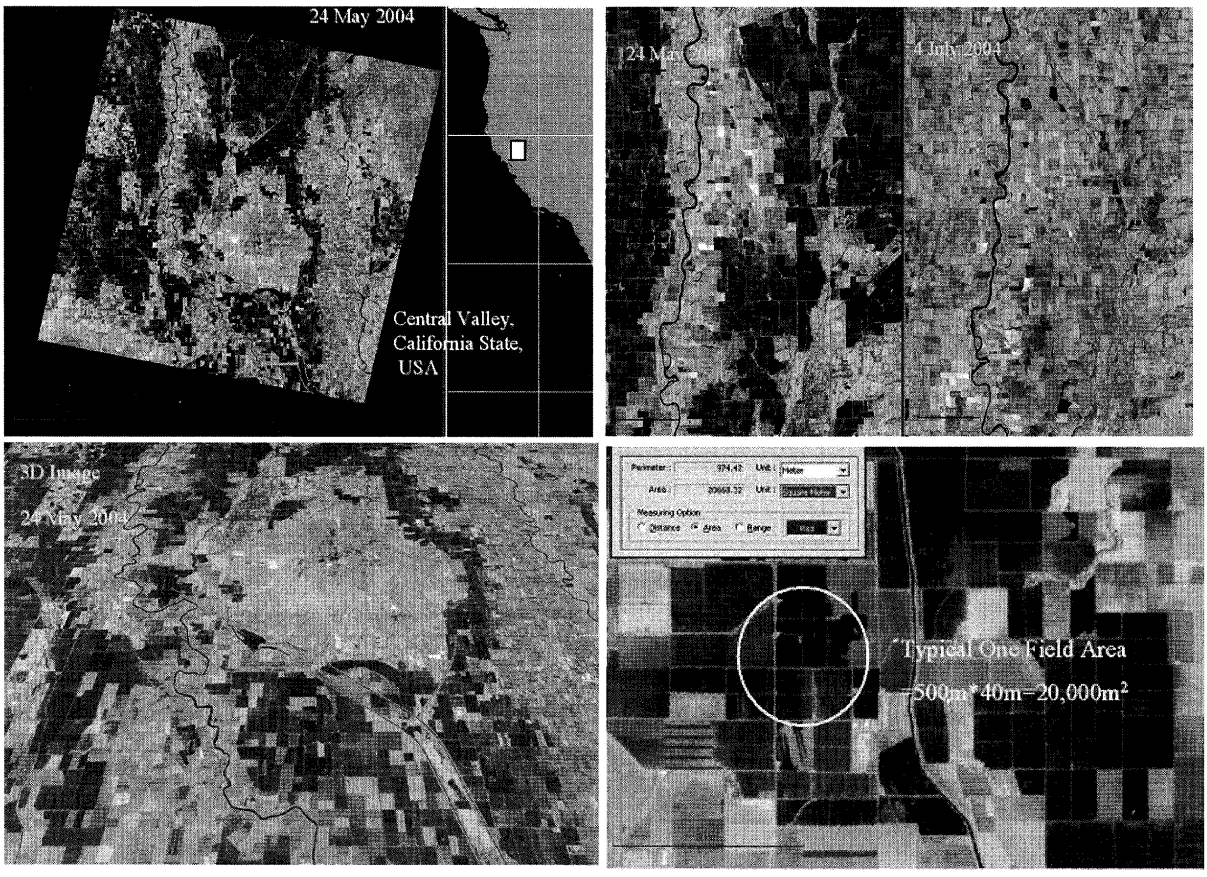

Fig. 7 Paddy fields in the Sacrament Valley, California, USA
Upper left: Total scene of ASTER data and the map of location Upper right: The images of in May and July
Lower left: 3D image of the Valley, California, USA Lower left: Field size of the valley

5. CONCLUSIONS

The study of "Determination of Local Characteristics at Global Agriculture Using Archive ASTER Data" has been developed and we have some results until now. The conclusions of the study at now are as follows,

1) Using ASTER images, we can easily understand agricultural characteristics of each local area.

2) ASTER data have high accuracy for location, and the accuracy is suitable for global study without the fine topographical maps.

3) By five years observation of ASTER, there are huge numbers of ASTER scenes, but not enough volumes for cloud free data for seasonal analysis. It means that follow-on program of ASTER is necessary.

4) We need not only paddy field, but also all crop fields and all area.

5) The studies are necessary to international corroboration.

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