Investigation on Development of Agricultural Monitoring System Using Satellite Data

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Abstract
ALOS sensors are observing at high resolution at terrestrial area, and are expected to provide us useful data for agriculture management. By the studies, the results as follows,
1) The situations of Japanese paddy field at early May is easily understood with the interpretation using AVNIR-2 data. 2) At Shonai area, paddy filed managements are well known by PALSAR data. 3) Irrigation system damages of Chuetsu-oki earthquake are observed with PALSAR data.
Keywords: Agriculture, Monitoring, Satellite Data

1. INTRODUCTION

ALOS satellite lunched at December 2006, and the earth observation satellite has two optical sensors and one SAR sensor. Those sensors are observing at high resolution at terrestrial area, and are expected to provide us useful data for agriculture management.

2. PROPOSE

For development of agricultural monitoring system, we study the abilities of ALOS data for agriculture. For the reason we test the data for application of agriculture.

3. Japanese paddy field at early May - Interpretation using AVNIR2 -

3.1 Strategy Japan is long country for north and south, and climatic conditions are very different, and we interpret the status of paddy fields various areas at 4th May 2006 in Japan using ANIR-2 data

3.2 Data
Image acquisition date is 4 May 2006 and it is the starting time of rice transplanting in the paddy fields. In Japan, Workers have holidays from 29 April to 5 May as the name of Golden week. Almost farmers have another jobs as employee of company and local government [1]. The AVINIR2 data are imported in ERDAS/Imagine as the geo-coded data and made large mosaic image of Hokkaido, Tohoku, and Kanto column and Kyushu column as Fig. 1. At the color composite, R is near infrared band, G is red band and B is green band.

3. 3 Results and discussion

3.3.1 Hokkaido Island, Tohoku area and Kanto area

The image of Hokkaido Island is Fig. 2; North Tohoku area is Fig. 3, Middle Tohoku area is Fig. 4, and North Kanto area is Fig. 5. On Fig. 2 and Fig. 5, there are clouds as white objects. At early May there are snows at the high mountain area, and almost white areas are snow in the Figs.
1) Ishikari Plain in Hokkaido Island
Fig. 6 is Ishikari Plain in Hokkaido Island. Red colors are winter wheat and grasses, and there is no water in rice paddy fields.
2) Iwate Prefecture in Tohoku area
Fig. 7 is Iwate Prefecture in Tohoku area. Red colors are winter wheat and grasses, and there is water in rice paddy field there is water in rice paddy fields.
3) Miyagi Prefecture in Tohoku area
Fig. 8 is Miyagi Prefecture in Tohoku area. Red colors are winter wheat and grasses, and there is water in rice paddy field there is water in rice paddy fields.
4) Tochigi Prefecture in Kanto area
Fig. 9 is Tochigi Prefecture in Kanto area. Red colors are winter wheat and grasses, and there is water in rice paddy field there is water in rice paddy fields.

Fig. 1 AVNIR2 data acquisition at 4 May 2006

Fig. 2 Hokkaido area at 4 May 2006

Fig. 3 North Tohoku area at 4 May 2006

Fig. 4 Middle Tohoku area at 4 May 2006

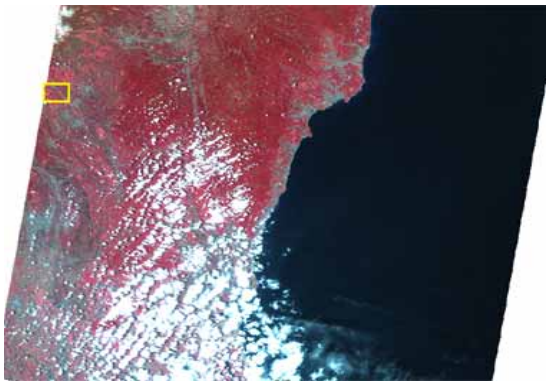

Fig. 5 North Kanto area at 4 May 2006

Fig. 6 Large image of Hokkaido Island

Fig. 7 Large image of Iwate Prefecture

Fig. 8 Large image of Migagi Prefecture

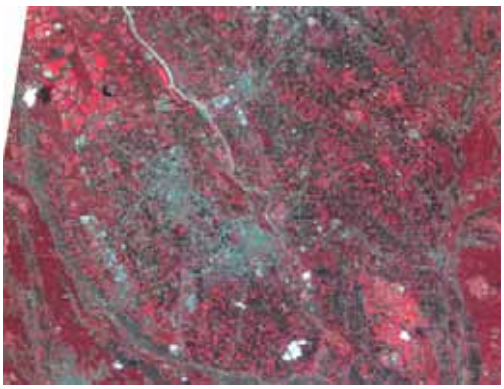

Fig. 9 Large image of Tochigi Prefecture

3.3.2 Kyushu Island

The image of north part of Kyushu Island is Fig. 10. The image is almost cloud and snow free. In the Hokkaido Island and Tohoku area is only one crop at one year, but Kyushu area is two crops such as winter and summer crop.

1) Saga prefecture

Fig. 11 is Saga prefecture in Kyushu Island. Almost fields are red color; there are winter wheat and barley in rice paddy fields in the area.

2) Kumamoto Prefecture -Aso Valley-

Fig. 12 is Aso Valley at Kumamoto prefecture in Kyushu Island. Red colors are winter wheat and barley, and there is water in rice paddy field.

4. Monitoring rice field using PALSAR

4.1 Strategy

In the East and Southeast Asian countries include Japan, growth of rice crop is at rainy season, and it is difficult to observation of the growth using optical sensor by clouds. Synthetic Aperture Radar (SAR) has the ability of pass through clouds and observing every weather condition and we are testing PALSAR ability of agriculture monitoring.

4.2 Data

Image acquisition dates are April to September in 2006. The PALSAR data of 28 April are multi-scenes from Akita Prefecture to Fukushima Prefecture (Fig. 13). The others are one or two scenes at Shonai Area in Ymagata Prefecture. Acquisition dates of used data are as follows; 28 April, 6 June, 22 July, 28 September in 2006.

4. 3 Results and discussion

Fig. 14 is over lay image of PALSAR and topographical map at mountain area, and there are some errors by fore shorting. Fig. 15 is that of plain area, and two images are very good fitting. At Fig. 15, there are dark fields and not dark fields, and back scattering mechanism is illustrated in Fig. 16. Dark fields are filled with water and not dark fields are no water.

There are four images in Fig. 17. At 28 April, only a few fields filled with water, and at 6 June almost fields filled with water. At 22 July and 28 September also almost fields filled with water.

At Shonai area, paddy filed managements are well known by PALSAR data

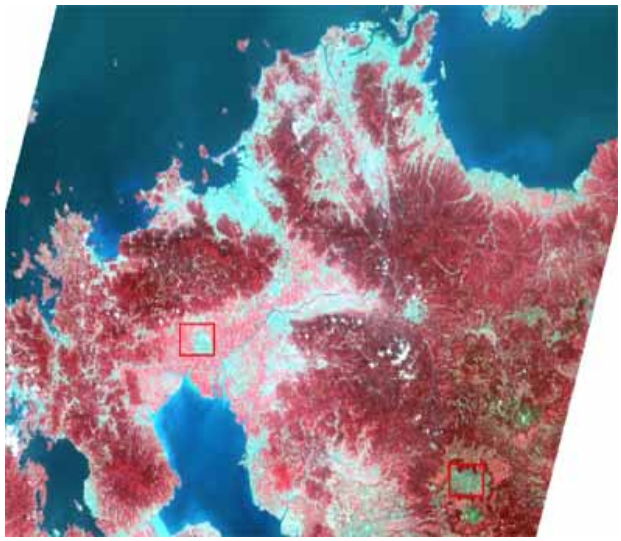

Fig. 10 Kyushu area at 4 May 2006

Fig. 11 Large image of Saga Prefecture

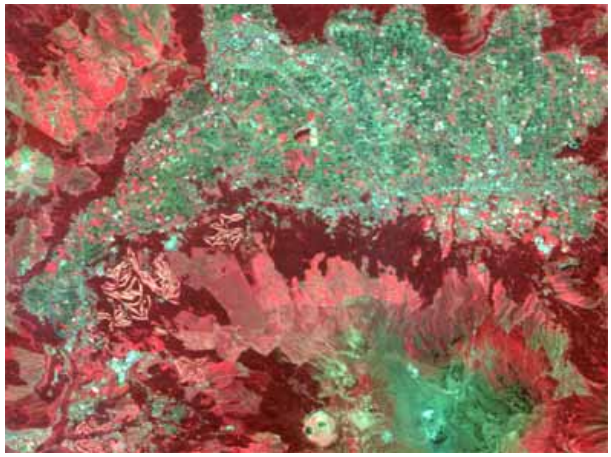

Fig. 12 Large image of Kumamoto Prefecture

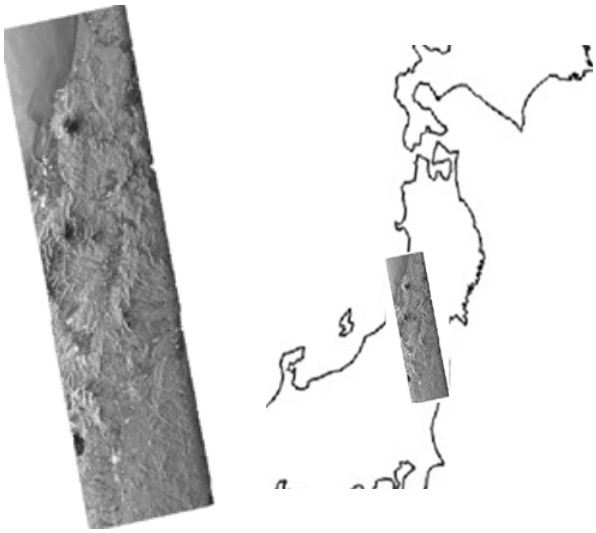

Fig. 13 PALSAR data at 28 April 2006

5. Disaster damage detection at Chuetsu-oki earthquake using ALOS data

5.1 Strategy

Japan has many natural disasters such as typhoon, volcanic eruption, earthquake etc and now, remote sensing is powerful tools for assessing the damage by the disaster. We try to assess agricultural damage of Chuetsu-oki earthquake at 16 July 2007 [2]. By the earthquake, some irrigation systems of steel pipes were damaged, and water supply was stopped at 2-3 weeks to paddy field.

5.2 The Earthquake and Satellite Data

Target area is indicated at Fig 18, and damage Map by Geographical Survey Institute in Japan is Fig 19. Used ALOS data are listed at Table 1.

5.3 Results and discussion

5.3.1 AVNIR2

Optical sensor of AVNIR2 has the limitation of clouds, and there is no suitable data for the analysis

5.3.2 PALSAR

PALSAR has the ability of acquisition at all weather condition, and there are the data of three days after the event. The color composite image of three dates is made as follows; R is 2007.7.19, G is 2007.7.20 and B is 2006.7.11. Bragg resonance backscatter (Fig 21) are observed at the paddy fields in particular observation angle.

Agriculture fields are interpreted as follows;

Black : Normal paddy (No Damage)

Blue : Bragg scatter at descending observation

Yellow : Bragg scatter at ascending observation

Pink : None water at paddy fields at the damage of irrigation system by the earthquake

Damage area are cycled at Fig.22 and upper cycle area is close-upped at Fig.23. At Fig 23, dried up paddy field are limited because there are many rainfalls at the irrigation system damage period.

Table 1 ALOS Data
The Earthquake :2007.7.16

Sensor	Date	Obs.Direc.	Scene No.
AVNIR2	2007.6.6	D	3
	2007.8.12	D	3
	2007.9.6	D	3
PALSAR	2006.7.11	A	1
	2007.7.19	A	2
	2007.7.30	D	2

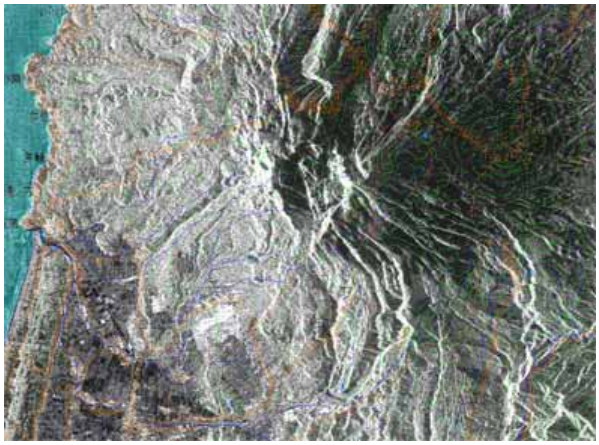

Fig. 14 Over lay image of PALSAR and topographical map at mountain area

Fig. 15 Over lay image of PALSAR and topographical map at plain area

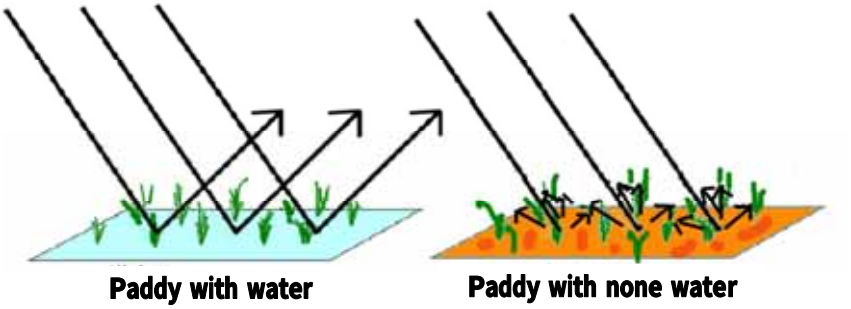

Fig. 16 Back scattering at water and bare soil

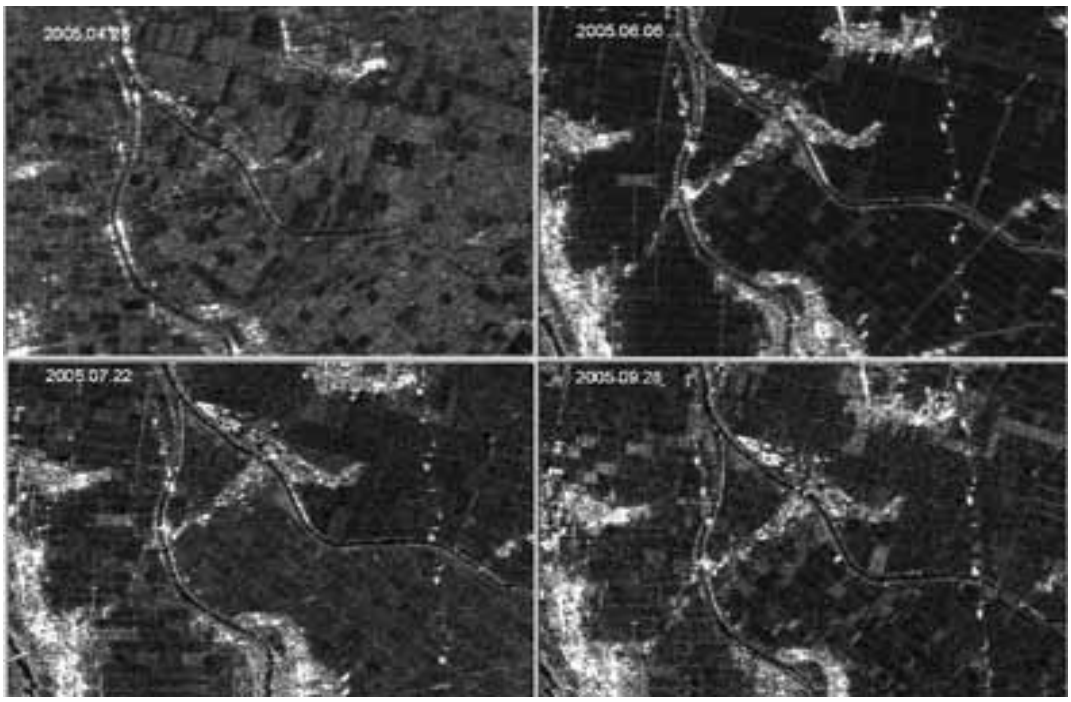

Fig. 17 Large image of PALSAR at Shonai area in 2006
Upper left: 28 April, Upper right: 6 June, Lower left: 22 July, Lower right: 28 September

Fig. 18 Target area of the study

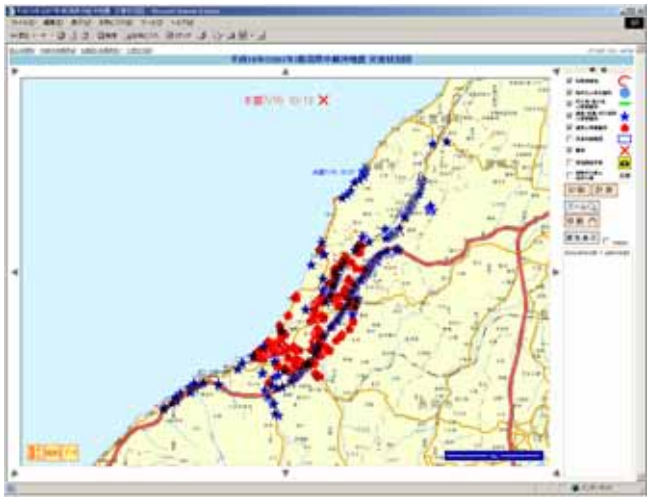

Fig.19 Damage Map made by GSIJ

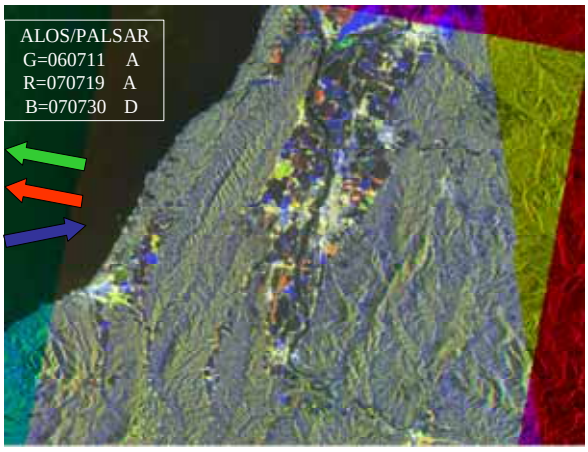

Fig. 20 Color composite image of three times

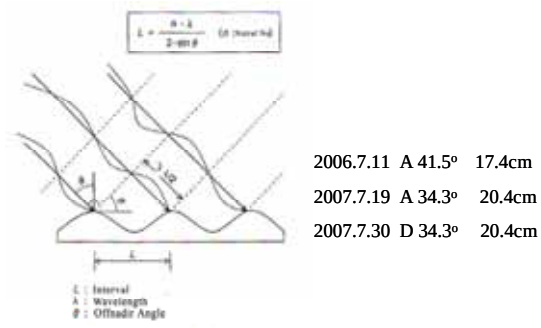

Fig. 21 Bragg resonance condition

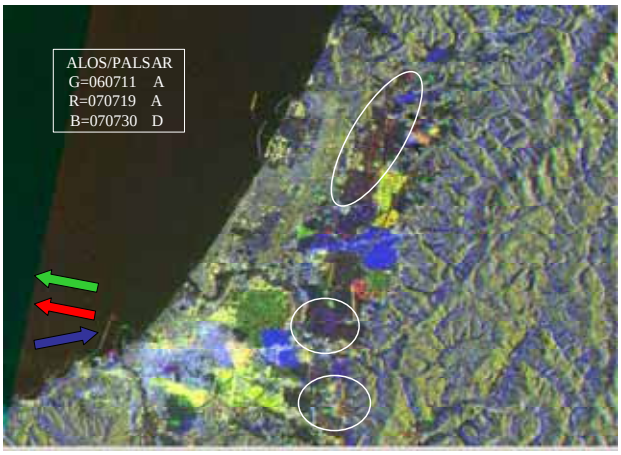

Fig. 22 Damage area at the image

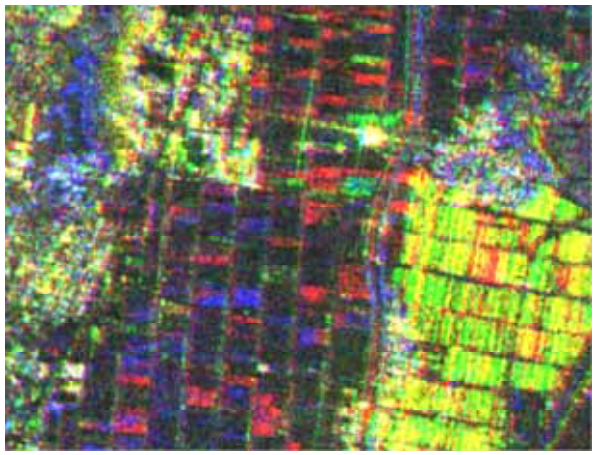

Fig. 23 Large image of color composite

6. Conclusions

ALOS data have the ability for agricultural monitoring and especially PALSAR sensor is powerful for East and Southeast Asian Countries.

Acknowledgement

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References

[1] The Ministry of Agriculture, Forestry and Fisheries of Japan (2006) Annual Report on Food,Agriculture and Rural Areas in Japan FY2005 (Summary), 73p

[2] Geographical Survey Institute, Ministry of Land, Infrastructure and Transport (2007) The Integrated Information of damage of Chuetsu-oki earthquake http://zgate.gsi.go.jp/2007chuetsuokijishin/index2.htm