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RICE PADDY MONITERRING USING RADARSAT DATA

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ABSTRACT: Every year, agricultural statistics section of the Japanese government announces rice planting paddy area and rice yield per ha. At present, the rice planting paddy area is calculated based on field survey by human power. The government wants to determine the rice planting paddy area using remote sensing. Already, several results come out using optical satellite. However, Japan has a rainy-season at crop growing time. It is difficult to observe paddy every year. Synthetic Aperture Radar (SAR) can observe earth surface without influence of clouds. We are developing estimation method of the rice planting paddy area using RADARSAT/SAR. Paddy fields were filled with water during rice-planting period. The microwave of SAR scatters at water surface like mirror, called 'mirror reflection'. This phenomenon makes backscatter of SAR small value at the water-covered area. The rice planting paddy area estimation method utilizes the characteristics, backscatter is very low by mirror reflection at transplanting time, and volumetric scatter increase with the growth. Our studying area is the Saga plain at southeast Japan. We used two RADARSAT images, 2/July/2000 and 27/July/2000. Two scenes were acquired in the same mode. The image of 2/July is the ending rice transplanting time, 27/July is season of rice grows, and backscatter of RADARSAT is increase. We determined rice planting paddy field as water area of 2/July minis that of 27/July. When the ratio of the estimated value for the statistics value is defined as the accuracy, the accuracy of the estimation is 97.8% in the aggregate, and the accuracy of each municipality is distributed between 25.8 and 120.9. The accuracy is lower the municipalities faced a mountainous region than flat plain. Their municipalities were influenced from fore-shortening and lay over phenomena, in other words, because it was calculated in two scenes, the position deviation of two scenes had an influence.

1. INTRODUCTION

Every year, agricultural statistics section of the Japanese government announces rice planting paddy area and rice yield per ha in Japan. At present, the rice planting paddy area is calculated with statistical method, based on field survey. The field survey carry out more than ten thousands fields at whole country by human power. The government wants to determine the rice planting paddy area using remote sensing technology. It hopes for reduce the costs and improve the accuracy of statistics. Already, several results come out using optical satellite,

and make a trial of estimation in Hokkaido (North island of Japan) in 1998-2000. Southeast Asia that includes Japan belongs to Asia-monsoon climate region, and there is a rainy-season at crop growing time. Therefore, the optical sensor satellite is difficult to observe in rainy season by clouds, and it is a big problem to publish the rice planting paddy area every year. Synthetic Aperture Radar (SAR) can observe earth surface every season without influence of clouds. Therefore, we are developing estimation method of the rice planting paddy area using RADARSAT/SAR.

2. STUDY AREA

Our studying area is the Saga plain in Kyushu Island that is at southeast Japan (Figure 1). The Saga plain is a part of Saga and Fukuoka prefecture. The Ariake sea is located south of the Saga plain and the Seburi mountains are north. Annual average temperature is 16? , rainfall is 1836mm. The main crop of summer is rice, and winter is wheat. The small crops in summer are corn, soybeans, and rush-grass(this is the ingredient of Japanese "TATAMI") , and also vegetables at small area.

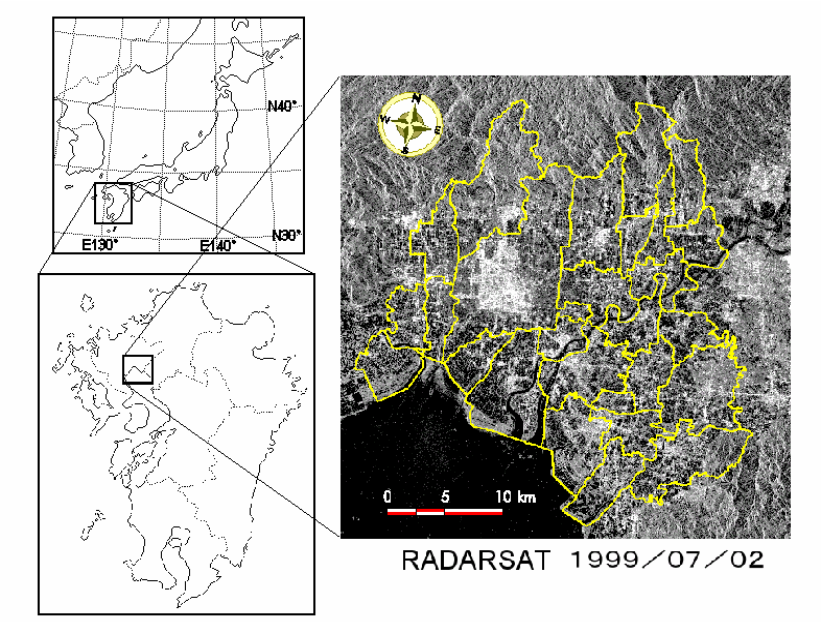

Figure 1 Study Area

3. EXPERIMENTS in 1999

In 1999 study, we use one RADARSAT image at 02/July, mode is Standerd_2 (S2), and that is the ending at transplanting time. We use path image, which is make by EarthView Advanced Precision Processor (APP) for SAR of Atlantis from signal data. Ground Control Points (GCPs) was dropped on the place at the plain part of the satellite image, and the UTM coordinate was given from the digital map 1:25,000 of the Geographical Survey Institute of Japan (GSI). After that, the sigma filter of 3 × 3 was applied

The paddy fields are filled with water during rice-planting period. RADARSAT has C-band (5.3GHz, 5.6cm wavelength) SAR. SAR is active sensor using microwave. Almost microwave scatters at water surfaces like mirror, called 'mirror reflection'. This phenomenon makes backscatter of SAR small value at the

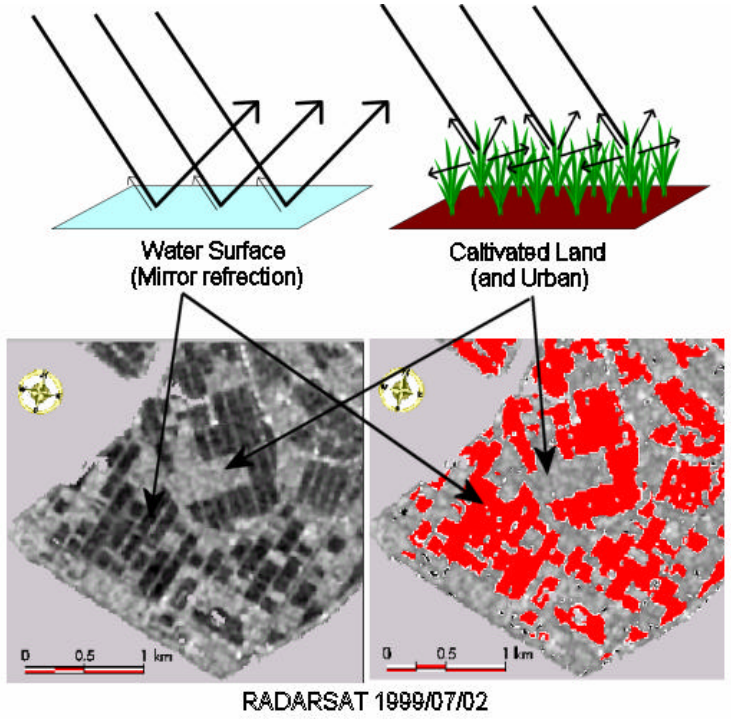

Figure 2 Extraction of the Rice Paddy Fields

water-covered area, rice paddy scatter can be distinguished as water surface at rice transplanting period. Figure 2 shows the extraction mechanism rice paddy from RADARSAT image in 1999, and Figure 3 shows the result that estimated value compared with statistical value

When the ratio of the estimated value for the statistics value is defined as the accuracy, the accuracy of the estimation is 111.0% in the aggregate. We investigated to get more high acccrcy result, and discover one of reason for misstake estimation. Figure 4 shows one of mistake case, and we arrange estimation method to correct mistake.

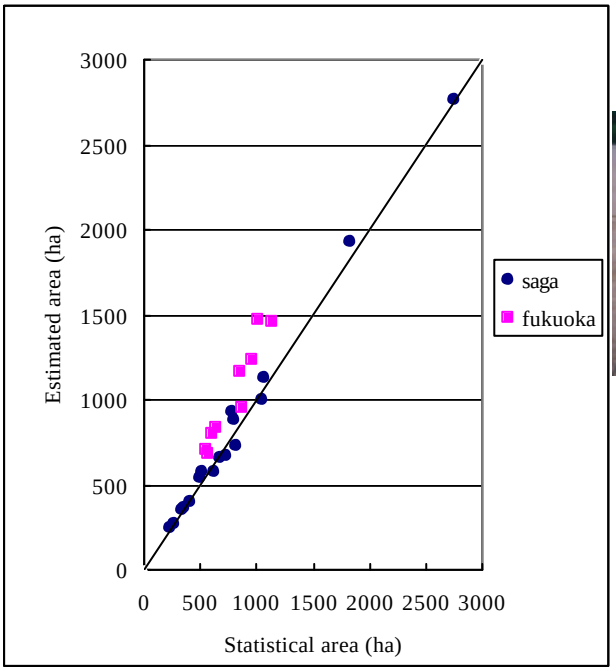

Figure 3 Comparisons of Statistical Area and Estimated Area in 1999

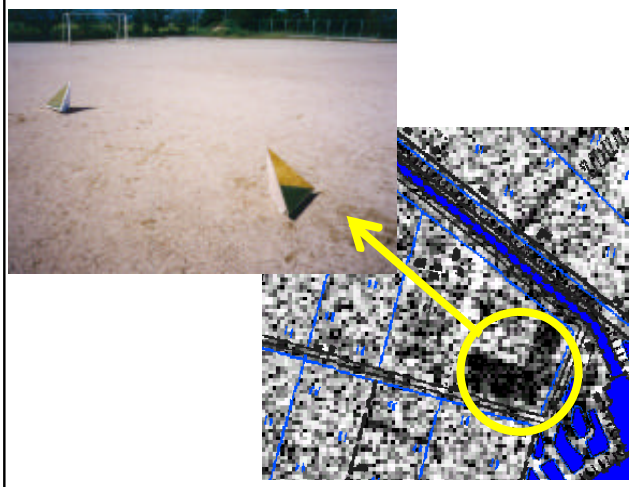

Figure 4 The case of Miss Extraction

4. EXPERIMENT in 2000

In this study, we used two RADARSAT images, 02/July/2000 and 27/July/2000 (Figure 5). Two scenes were acquired in the same S2 mode, and we use path images and same treatment as 1999 experiment. The image of 02/July is the ending rice transplanting time, and very small backscatter of RADARSAT at rice planting paddy fields (Figure 5 left), which of 27/July is season of rice grows, and the backscatter is increase (Figure 5 right). This estimation method utilizes the characteristics, backscatter is low by mirror reflection just after transplanting, and volumetric scatter increase with the growth.

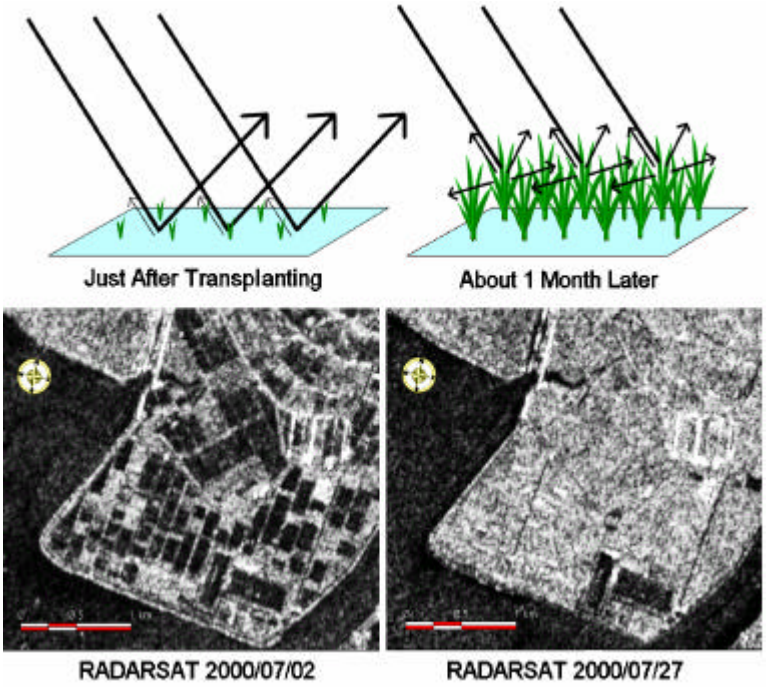

Figure 5 Change of Backscatter at the Rice Planted Paddy Fields

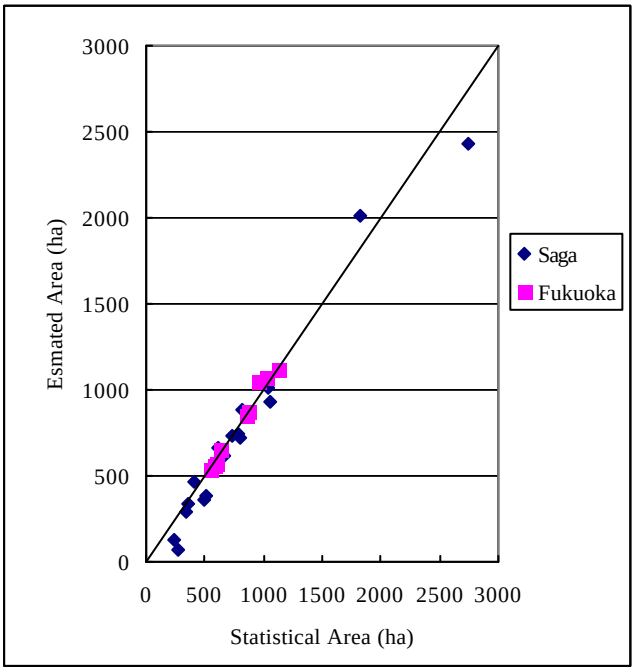

Figure 6 Comparison of Statistical Area and Estimated Area in 2000

The filled water area like a paddy fields has the characteristics that become dark due to mirror reflection in the SAR image. We extracted dark part as water area from each images Digital Number (DN) using threshold. The water area where it is extracted from RADARSAT image of 2/July contains water, paddy, and flat bare ground that caused mirror reflection because it was very smooth surface (for example Figure 4). The water area where it is extracted from RADARSAT image of 27/July contains water, not-planted paddy and flat bare ground. About one month in summer, grows rice and increase backscatter of RADARSAT. Therefore planted paddy become bright in the image, against not –planted paddy stay dark. Usually, not-planted paddy keeps filled water condition because of acts against weeds.

We determined rice planted paddy fields as water area of 2/July minis that of 27/July. The vector boundaries of cities, towns and villages were made from the digital map 25,000 of GSI, and the rice planting paddy area each municipality were determined, and compared with statistics value at the end.

Figure 6 shows results in this method using two RADARSAT

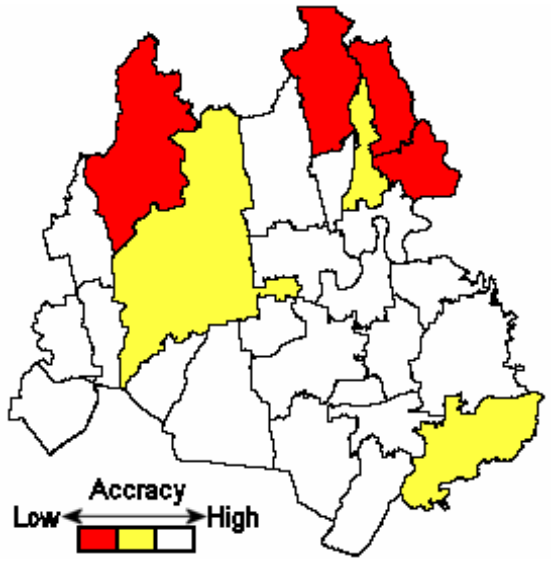

Figure 7 Choropleth Map of Accuracy

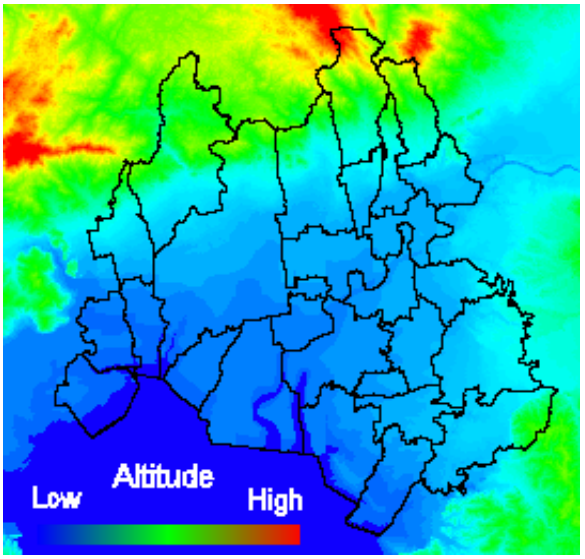

Figure 8 Topology of Study Area

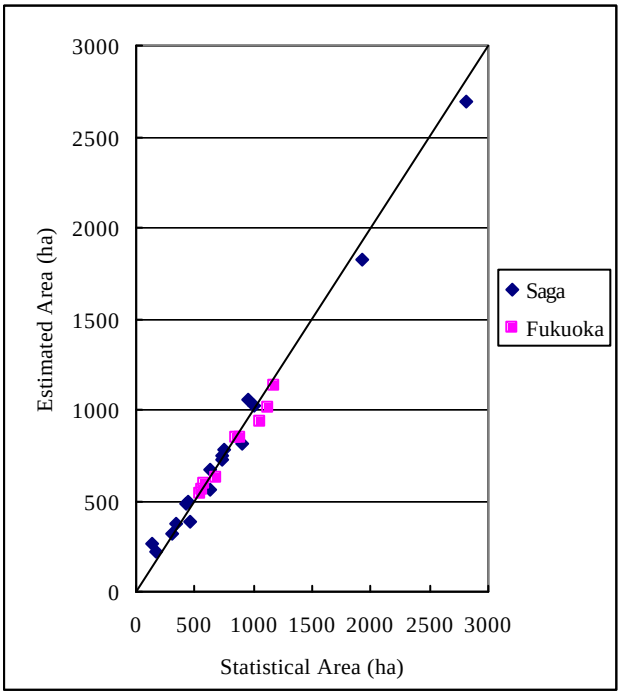

Figure 9 Comparison of Statistical Area and Estimated Area in 2000 with Geo-metrical correction using DEM

images. The accuracy of the estimation is 97.8% in the aggregate. It can be said that a good result could get it on the whole. However, the accuracy of each municipality is distributed between 25.8 and 120.9, standard deviation was 19.2.

The accuracy is lower the municipalities faced a mountainous region than flat plain (Figure 7 & 8). Their municipalities were influenced from fore-shortening and lay over phenomena, in other words, because it was calculated in two scenes, the position deviation of two scenes had an influence. It is necessary to geo-metrical correction using Digital Elevation Model (DEM). We tried simple geo-metrical correction using 50m DEM of GSI. Figure 9 shows results of this method with geo-metrical correction using DEM. The accuracy of the estimation is 101.6 in the aggregate, and the accuracy of each municipality is distributed between 53.8 and 122.0, standard deviation was 13.1. It can be said that a better result could get it by geo-metrical correction.

5. CONCLUSIONS

There are the conclusions of this research.

- We could get a good result by using two scenes of SAR data of just after trans-planting time and growing time.
- The influence of the geographical features was examined. Errors were big at a mountainous region.
- The error could be smaller by the geo-metrical correction using DEM.

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