DISCRIMINATION OF EARLY MATURING PADDY RICE CROPS USING MULTI-TEMPORAL SAR IMAGES

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ABSTRACT ... This study was begun to classify the paddy fields by the rice varieties and to monitor the temporal change in rice growth using SAR backscatter coefficients (σ°). For nine fine-beam mode images of Radarsat-1 SAR, a growing period time-series of backscatter coefficients was set up from April to October in 2005, and was compared with the field-measured rice growth parameters such as LAI (leaf area index), plant height, fresh and dry biomass, and water content in grain and plant for 45 parcels in Dangjin-gun, Chungcheongnam Province, South Korea. The average backscatter coefficients for early-maturing rice varieties (13 parcels) were ranged from -18.17dB to -6.06dB and were lower than for medium-late maturing rice varieties during most of the growing season. At around the heading stage (July 30) for early-maturing rice, both rice crops showed the highest backscatter coefficient values and the difference was the greatest before harvesting early-maturing rice. The temporal difference in backscatter coefficients between rice varieties was expected to play a key role to identify early-maturing rice fields. On the other hand, comparison with field-measured rice growth parameters showed that the backscatter coefficients decreased or stayed on the plateau after heading stage even though the growth of rice canopy advanced.

KEY WORDS: Backscatter coefficient, Early maturing rice, Paddy, RADARSAT, Rice, SAR

1. INTRODUCTION

Paddy rice, a primary crop in South Korea, can be categorized into two groups, early maturing rice and medium-late maturing rice, from the viewpoint of growth cycles. The knowledge on the amount and the spatial distribution of cultivation area by the rice varieties is now perceived as essential to environmental management as well as the advancement of agricultural statistics in that the change of land cover after harvesting makes different hydrologic and ecologic response and the yield and the flow to food markets takes an effect on government policy on food supply and safety. Unfortunately, we did not have yet any feasible way of getting such information. However, the advancing remote sensing technology is now expected to have the answer.

In Asian countries including Korea under the condition of monsoon climate, using radar-based remote sensing data is known as a strongly practical approach for nationwide mapping of rice fields and identifying of the growing cycles (Lee & Hong, 1999), and different studies have been conducted to classify paddy rice fields using different polarized SAR (Synthetic Aperture Radar) images such as RADARSAT, ENVISAT, ERS, and so on (Chakraborty et. Al, 2005; Hong et. al, 2000; Toan et. al, 1997). In case of using multi-temporal images, it is fundamentally based on the temporal biomass change of rice fields distinguished from other land cover condition. If early maturing rice is to be identified within paddy fields, the reference should be another one like medium-late maturing rice fields. As such, it is first needed to understand the temporal growth variation of each rice type and to investigate the correlation between rice growth and SAR data because the knowledge about similarity and dissimilarity between both rice varieties helps decide which date of radar images are useful to discriminate them.

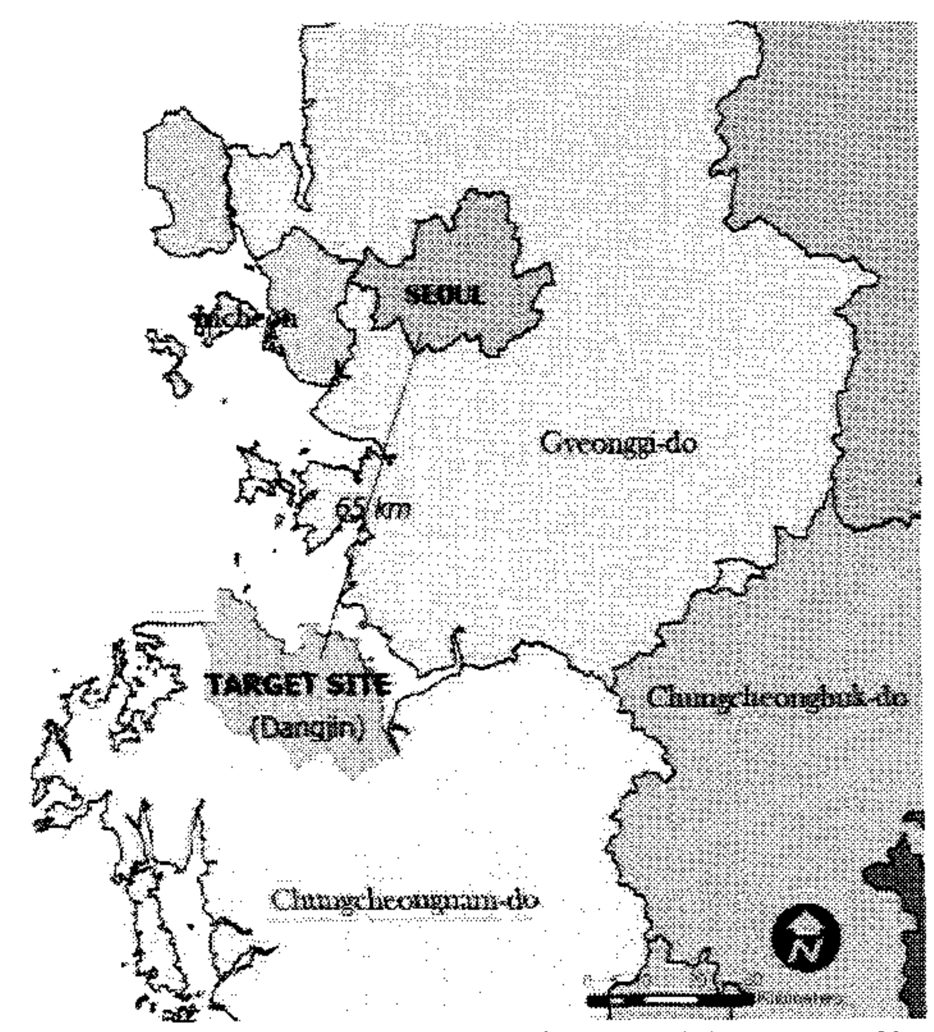
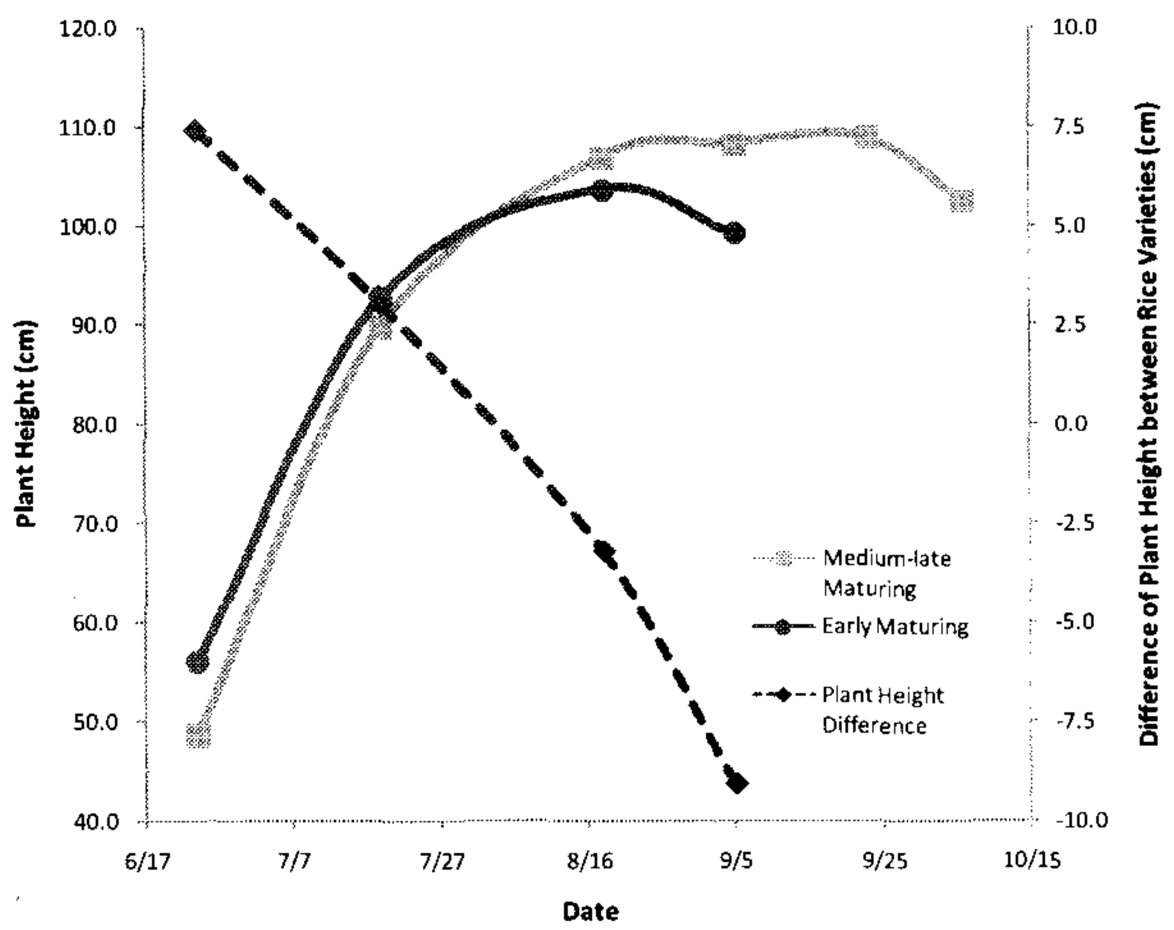


Figure 1. The study site is located in Dangjin-gun, Chuncheonggnam Province about 65km away from Seoul, South Korea and six rice growth parameters were observed for 45 paddy rice parcels

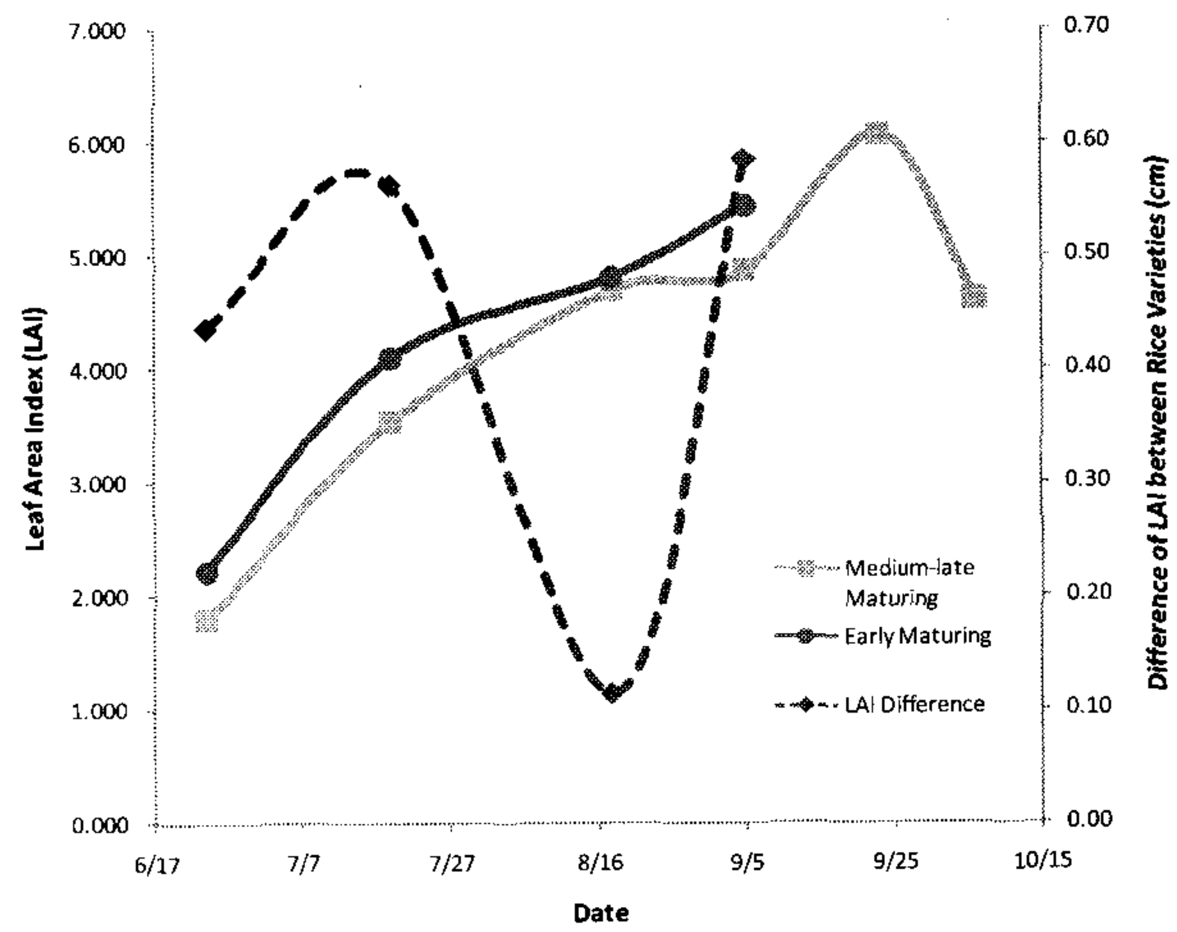
This paper discussed the quantitative difference of growth parameters between early maturing rice and medium-late maturing rice by growth stages and analyzed the relationship between the growth parameters and backscatter coefficient of RADARSAT images.

2. STUDY SITE AND FIELD MEASUREMENTS

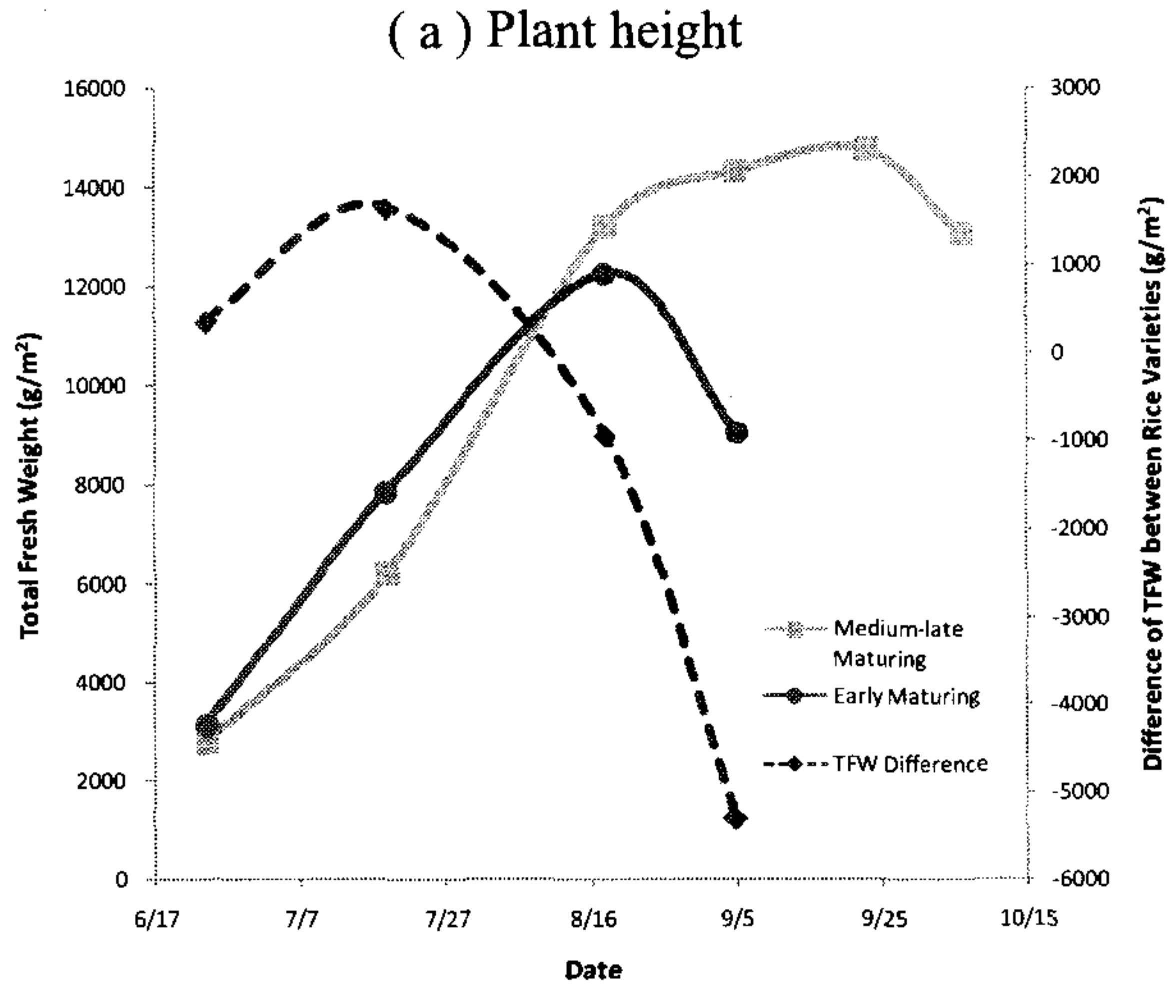
The study site was chosen in Yedang irrigated plain, Dangjin-gun, Chungcheongnam Province, about 65km south of Seoul. The Yedang irrigated plain is the second largest agricultural land of South Korea, and in general the planting begins in middle of May and the harvesting ends in from early September to middle October according to the rice varieties. In 2005, six rice growth parameters have been observed at thirteen parcels for early maturing rice and thirty two parcels for medium-late maturing rice: plant height, LAI (leaf area index),



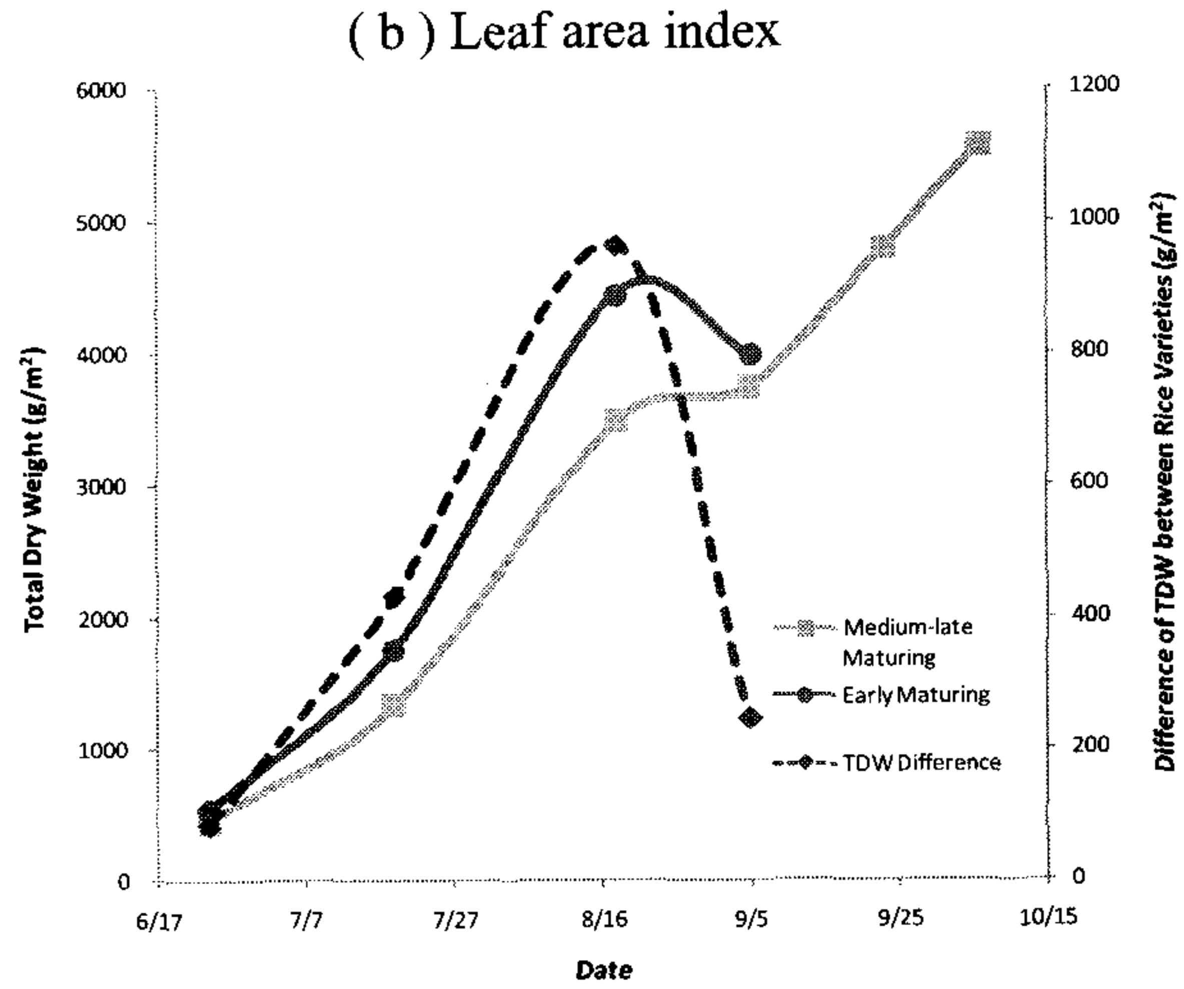
(a) Plant height



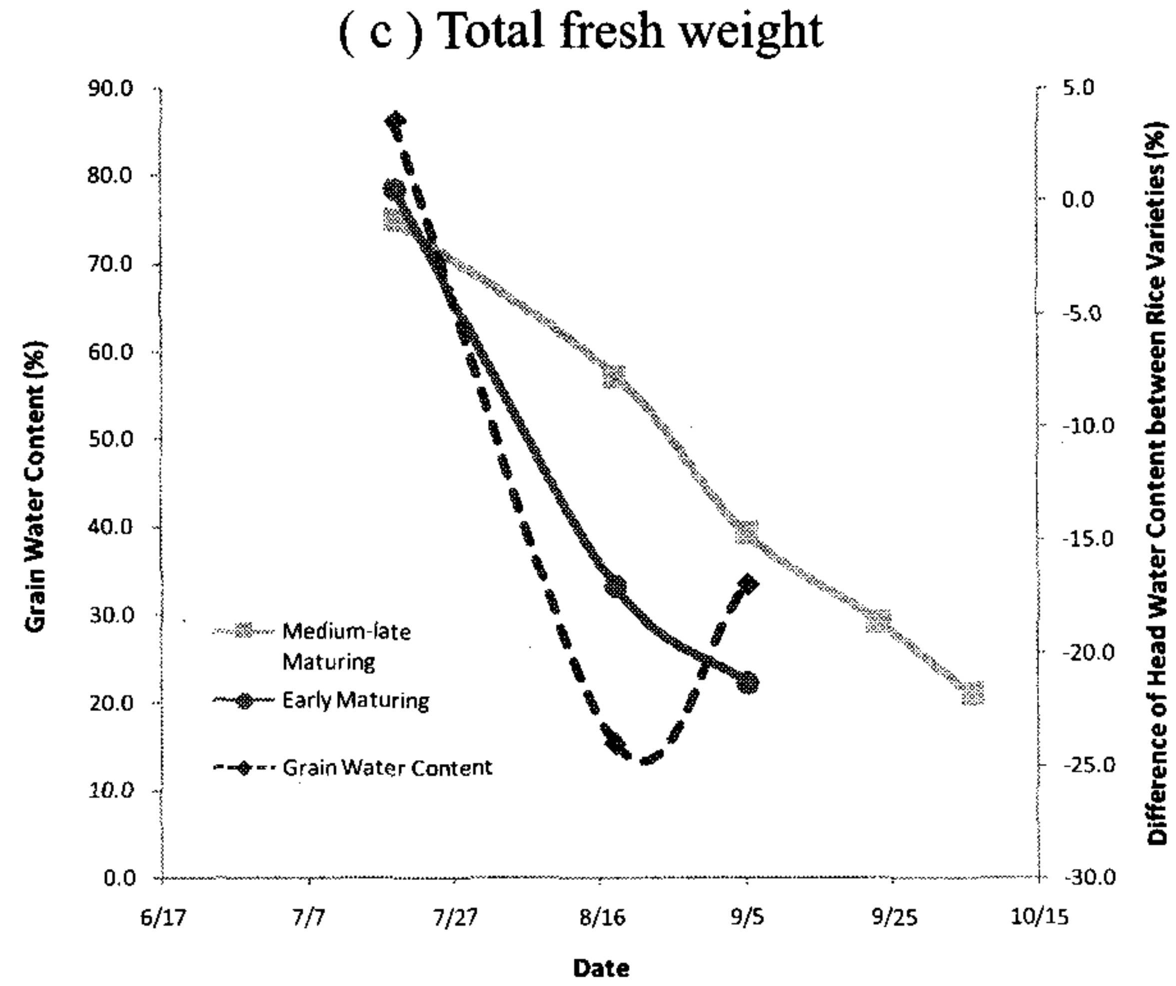
(b) Leaf area index



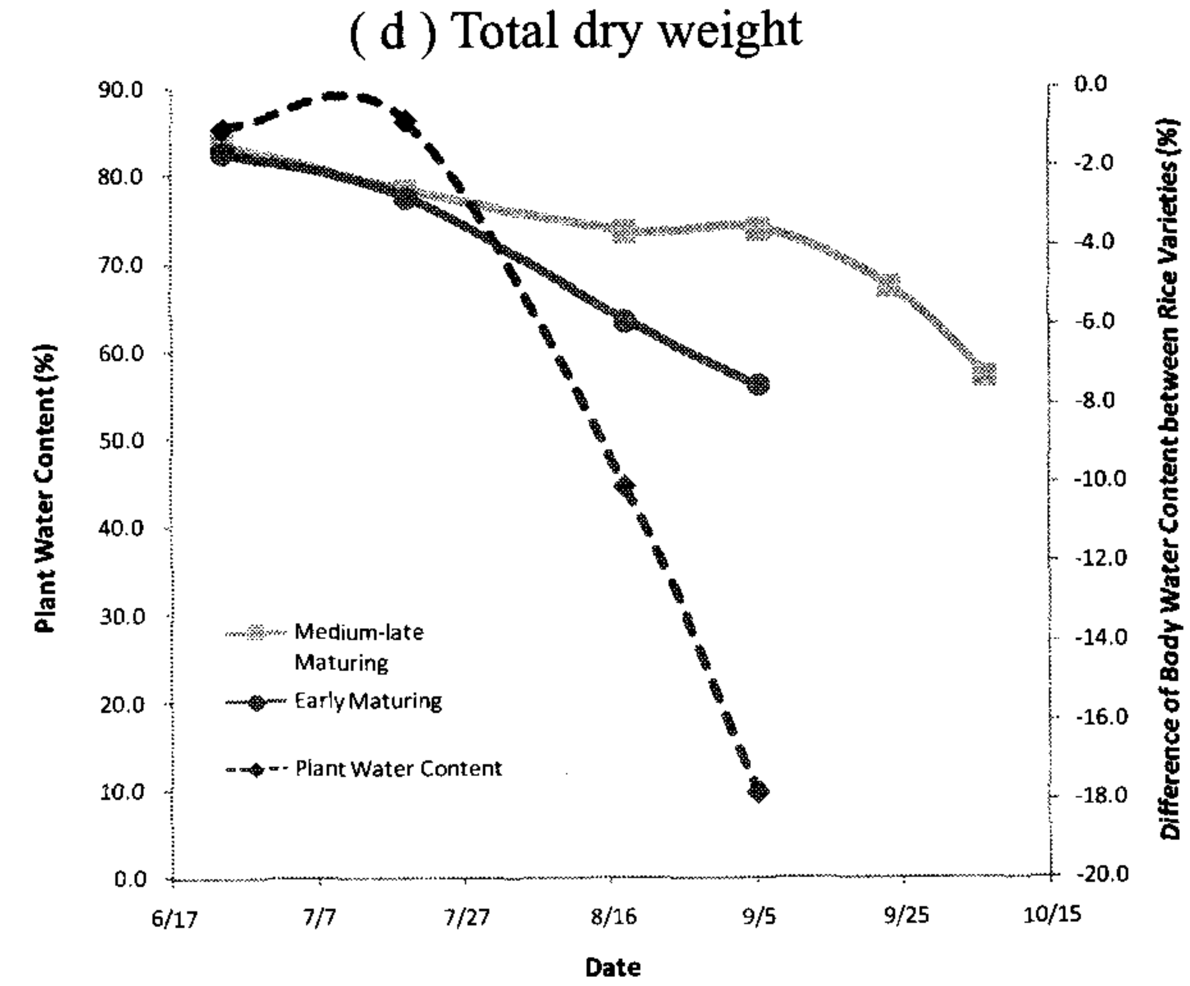
(c) Total fresh weight



(d) Total dry weight



(e) Grain water content



(f) Plant water content

Figure 2. Comparison of crop growth parameters between early maturing rice and medium-late maturing rice. Growth parameters which could afford to recognize the type of rice were different depending growth stages.

total fresh weight (TFW), total dry weight (TDW), grain water content (GWC), and plant water content (PWC).

3. SAR DATA COLLECTION AND PROCESSING

As for the period of growing season in 2005, all nine Fine-beam mode RADARSAT SAR images were collected and were transformed into the coordination system of Transverse Mercator. The backscatter coefficient was retrieved using the SARscape software and the basic statistics were calculated in paddy parcels. Figure 3 shows temporal variation of mean backscatter coefficient in a unit of parcel according to rice varieties.

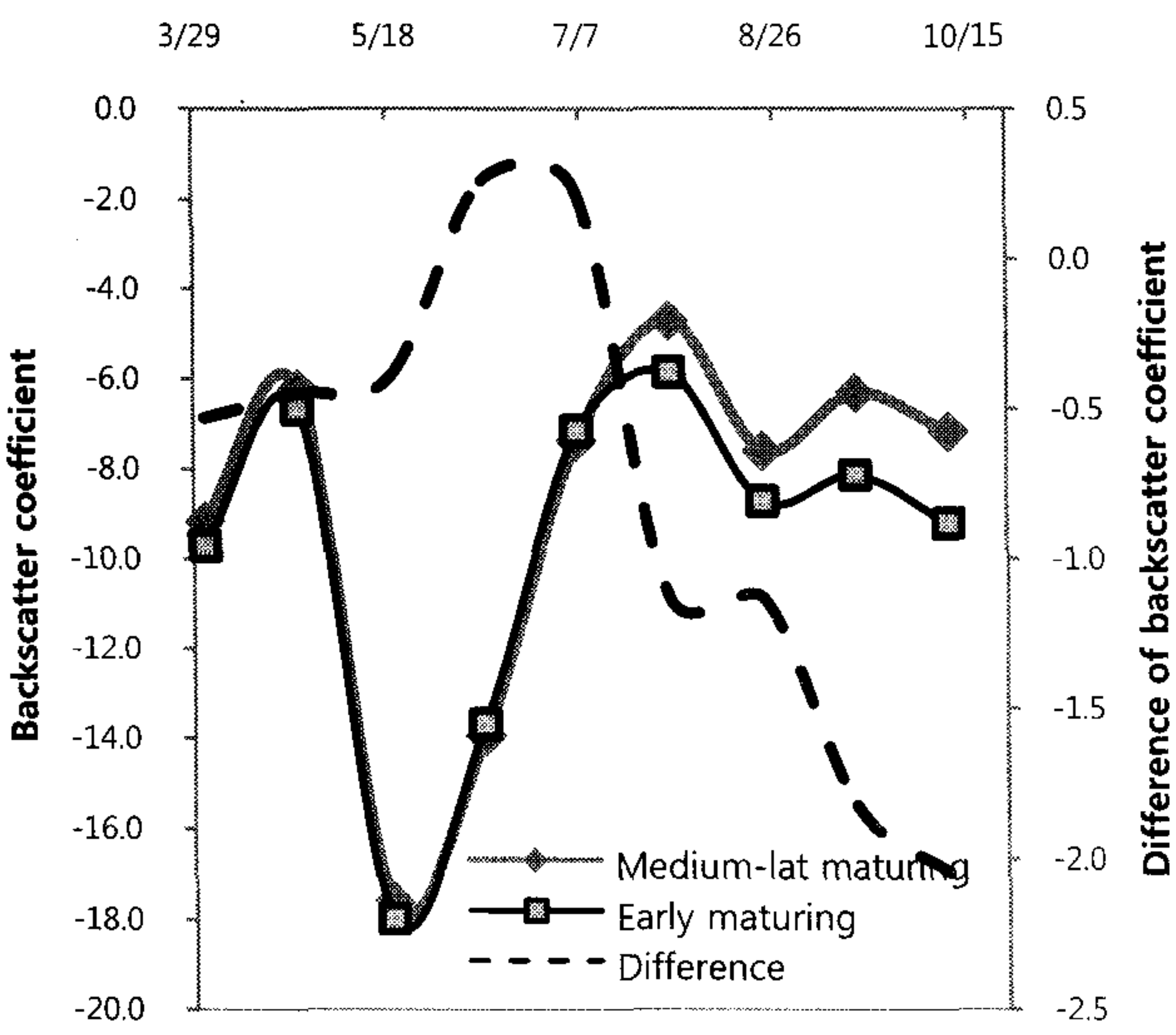


Figure 3. Temporal variations of backscatter coefficient from RADARSAT fine-beam mode images. The gap of backscatter coefficients apparently increased after middle July corresponding to heading stage of early maturing rice.

4. RESULTS

Early maturing rice is planted in expectation of faster harvest than medium-late maturing rice, and it leads to a gap of growth cycles. The temporal discord between both rice types could be described in different ways like Figure 2. The results show that which growth parameters are more helpful at identifying early maturing rice fields according the growth stages: plant height and LAI at around tillering stage, TFW and TDW at panicle differentiation stage before heading, and GWC and PWC after heading stage of medium-late maturing rice. With respect to temporal variations of backscatter coefficient from RADARSAT SAR images (Figure 3), the range of gap between both rice types got wider after middle July, that is, heading of early maturing rice, and it was convinced that early maturing rice fields could be distinguished using SAR images after middle July in advance of harvesting season. Eventually, three SAR data observed in July 6th, July 30th and August 23th were available except for after harvesting, and the paddy fields cultivating early maturing rice were extracted by the way of statistical methods on the average backscatter coefficient by paddy parcels as shown in Figure 4.

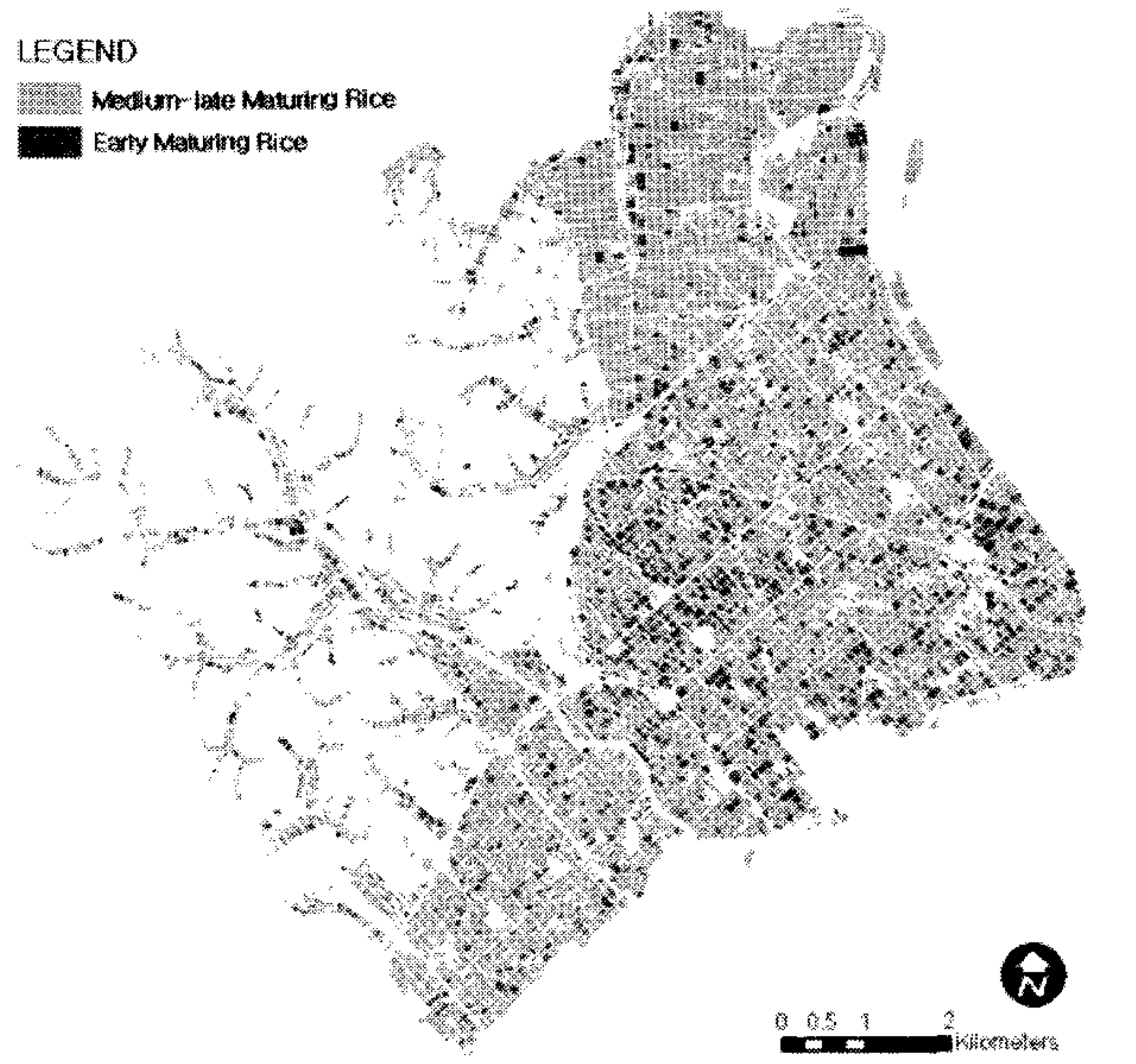


Figure 4. Rice cultivation map showing the cultivation parcels of early maturing rice.

5. CONCLUSION

In order to discriminate the paddy fields of early maturing rice, extensive ground survey and analysis of multi-temporal RADARSAT SAR images were carried out. The results revealed that RADARSAT images prior to the heading stage of early maturing rice, around middle July, were not useful to discern between rice varieties.

References

Chakraborty, M., K. R. Manjunath, S. Panigrahy, N. Kundu and J.S. Parihar, 2005. Rice Crop Parameter Retrieval Using Multi-temporal, Multi-incidence angle Radarsat SAR Data. *ISPRS Journal of Photogrammetry and Remote Sensing*, 59(5), pp.310-322

Hong, S. Y., S. H. Hong, and S. K. Rim, 2000. Relationship between RADARSAT Backscattering Coefficient and Rice Growth. *Journal of the Korean Society of Remote Sensing*, 16(2), pp.109-116

Lee, K. S. and C. H. Hong, 1999. L-band SAR Monitoring of Rice Crop Growth. In: *International Symposium on Remote sensing*, Seoul, South Korea, vol. XV, pp.479-484.

Toan, T. L., F. Ribbes, L. F. Wang, N. Floury, and K. H. Ding, 1997. Rice Crop Mapping and Monitoring Using ERS-1 Data Based on Experiment and Modeling Results. *IEEE Transactions on Geoscience and Remote Sensing*, 35(1), pp.41-56.