CROP SPECIES RECOGNITION AND DISCRIMINATION PADDY-RICE-GROWING-FIELDS FROM REAPED-FIELDS BY THE RADAR VEGETATION INDEX (RVI) OF ALOS-2/PALSAR2

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ABSTRACT:

The Japanese ALOS-2 satellite was launched on May 24th, 2014. It has the L-band SAR, PALSAR-2. Kim,Y. and van Zyl, J.J. proposed a kind of Radar Vegetation Index (RVI) as RVI = 8 * σ^0_{hv} / (σ^0_{hh} + σ^0_{vv} + 2* σ^0_{hv}) by L-band full-polarimetric radar data. Kim, Y. and Jackson,T.J., et al. applied the equation into rice and soybean by multi-frequency polarimetric scatterometer above 4.16 meters from the ground. Their report showed the L-band was the most promising wave length for estimating LAI and NDVI from RVI. The author tried to apply the analysis to the actual paddy field areas, both Inashiki region and Miyagi region in the eastern main island, ñHonshuò, areas of Japan by ALOS-2/PALSAR-2 full-polarimetry data in the summer season, the main crop growing time, of 2015. Judging from conventional methods, it will be possible to discriminate paddy rice growing fields from reaped fields or the other crops growing fields by the PALSAR-2 data. But the RVI value is vaguely related to such land use or biomass at the present preliminary experiment. The continuous research by the additional PALSAR-2 full-polarimetry data should be desired.

1. INTRODUCTION

Most of the earth-observation-satellite in operating now, are the satellite equipped with SAR sensors. Japanese SAR satellites are the L-band SAR. But as its polarization is only HH polarization and its wave length is rather long, the estimation of paddy-rice-planting-area is only for practical use.

As SAR data of earth surface can be obtained in case of cloudy weather, this is an advantage of agricultural applications, such as crop species recognition or estimation of crop biomass. All-weather data collection characteristic using the L-band SAR is important for agricultural applications.

2. RADAR VEGETARTION INDEX (RVI)

2.1 History of RVI

Kim and van Zyl (2001) proposed a kind of radar vegetation index (RVI). RVI = 4*min(λ 1, λ 2, λ 3) / (λ 1 + λ 2 + λ 3) They modified the equation as follows. (2009)

RVI = 8 * σ $^0_{hv}$ / (σ $^0_{hh}$ + σ $^0_{vv}$ +σ $^0_{hv}$)

by L-band full-polarimetric SAR data. They applied it into rice crop and soybean. (Kim, Jackson et al., 2012) Their experiment was performed by the L-band full polarization sensor above the field collecting data every 10 minutes during the crop grown season. They compared RVI for L-, C- and X-bands to crop growth data, LAI and NDVI. They found L-band RVI was well correlated with Vegetation Water Content, LAI and NDVI. But the field data were collected by the multifrequency polarimetric scatterometer. The platform height was 4.16 meters from the ground. And they reported that the RVI is effective to estimate VWC, vegetation water content. Their VWC is useful for the estimation of soil moisture or drought, according to Kim and Jackson, et al.

2.2 Method of RVI caliculation

The ALOS-2/PALSAR-2 JAXA processing level 1.1 data and level1.5 are converted from the DN (digital number) into backscattering values by the following equation.

σ^0 slc = 10 * $\log_{10}$ ($I^2 + Q^2$) + CF_1 ï A (for Level 1.1)

σ^0_{Q16} = 10*$\log_{10}$ (DN^2) + CF_1 (for Level 1.5)

NOTES
CF_1 = -83.0 (constant)
A = 32.0 (constant)

Every digital number for HH, HV, VV, which mean the polarization, were converted into NRCS number. And RVI, radar vegetation index, was calculated by the following equation.

RVI = (8 * $\mathring{u}^0_{HV}$) / ($\mathring{u}^0_{HH}$ + $\mathring{u}^0_{VV}$ + 2 * $\mathring{u}^0_{HV}$)
(RVI: radar vegetation index)

3. STUDY AREA

The field survey area was both sides along the lower course of

stream of theò Toneò river in the Kanto plain of Central part of Japan. There are upland wheat fields or lotus paddy fields scattered among paddy rice fields in this area. Lotus roots are a kind of foodstuff of Japanese dishes. Geographical features are flat and somewhere its drain is bad. Therefore there are some drainage pump stations in this area. And field data were collected on August 17th and 24th, 2015. Its items were whether the paddy rice was still growing or already reaped, what kind of crop was, such as paddy rice, barley, wheat, lotus roots. Paddy rice is including cereals, forage-grain-rice, whole-crop-silage rice plant.(Figure 2., Figure 3.) Lotus root is a kind of ingredients for Japanese cuisine.

Figure1. Study area near Tokyo and ALOS-2 observation strip of land (red- coloured-band-image, on the Google earth)

Figure 2. Whole-crop-silage-paddy rice, its harvest and its roll-bale-silage (Ministry of Agriculture, Forestry and Fisheries, 2016a)

Figure 3. Lotus roots and its harvest in a lotus pond (Ministry of Agriculture, Forestry and Fisheries, 2016b)

4. SATELLITE DATA

The ALOS-2/PALSAR2 satellite was launched on May 24th, 2014 and its data distribution to the public was started on Nov. 25th, 2014. The opportunity of full-polarimetry data acquisition around Japan is limited as the following table at the first observation year.

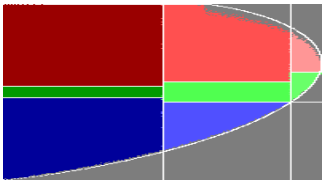
Cycle	Start date	Descending	Ascending
28	03-Aug-15	Any mode	FP(3)R 25°
29	17-Aug-15	W2(2)R 26.2°-41.8°	FP(4)R 28°
30	31-Aug-15	U2(6)R 29.1°	FP(5)R 30.4°
31	14-Sep-15	U2(7)R 32.4°	FP(6)R 32.7°
32	28-Sep-15	U2(8)R 35.4°	FP(7)R 34.9°

Table 1. ALOS-2/PALSAR2 observation plan around Japan

The ALOS-2/PALSAR2 data on August 25th, 2015 were used in this study. The data processing levels were level 1.1 and level 1.5 by JAXA and RESTEC format (CEOS format).

5. CONVENTIONAL METHOD

The Entropy-Alpha(H-alpha) decomposition method is one of the conventional analytical method for in-coherent scattering. Its result both sides along the lower ôToneô river course was shown in Figure 4. as follows. This calculation process was done by the polSARpro software, ver 5.04. The result image was rather rough, so its version might have some software bugs.



H-alpha classification plane

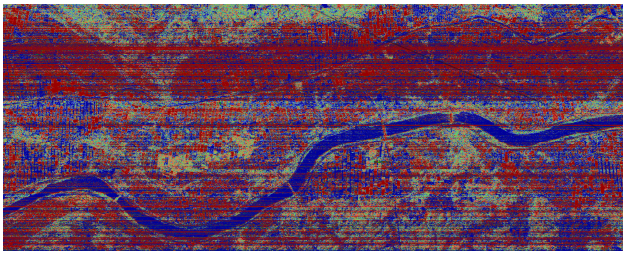
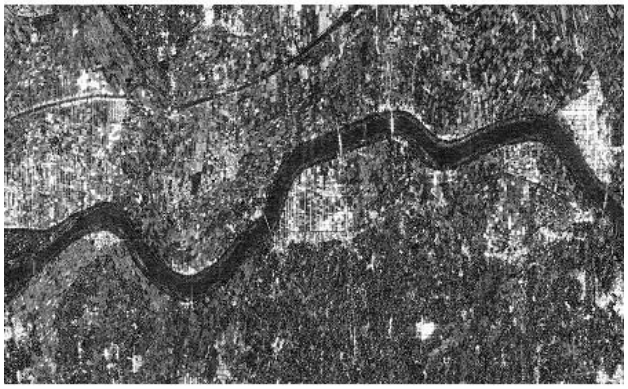
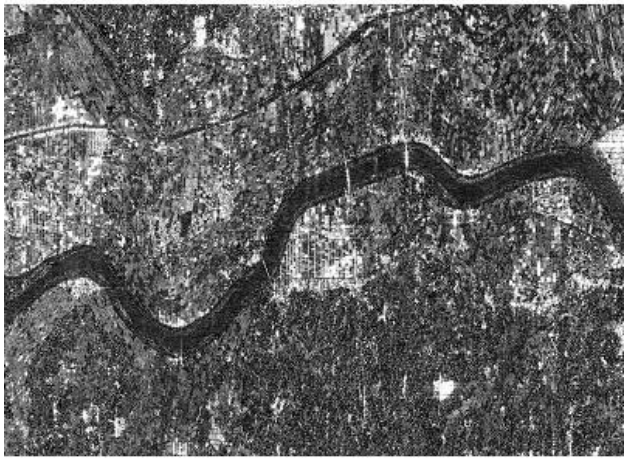


Figure 4. H-alpha decomposition

AS for another conventional method, there was the Yamaguchiôs 4 components decomposition method. The result was divided into 4 parts, odd, double, volume, helix scattering. (Figure 5.) It seems to represent the right condition of land use.



Odd



Dbl

Vol

Hlx

Figure 5. Yamaguchiôs 4-Component Decomposition

The Wishhart H/A/Alpha classification method is a kind of unsupervised classification methods. (Figure 6.)

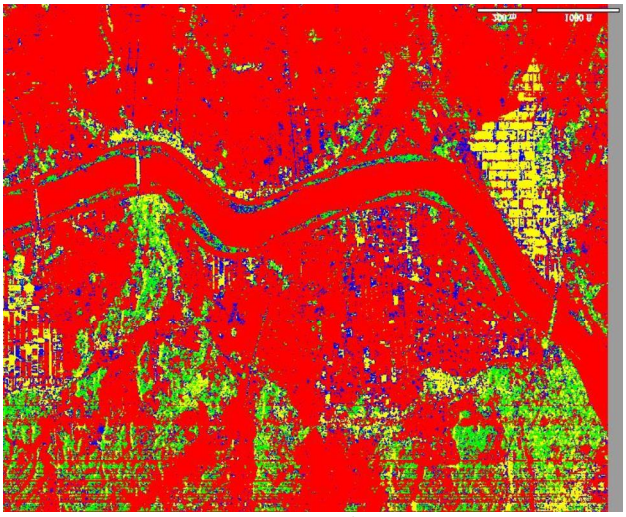


Figure 6. Wishart supervised classification

6. RVI RESULT

The Radar Vegetation Index (RVI) result and field survey data in this area was indicated in Fugure 7. The white coloured rectangles meant mainly the reaped paddy rice fields and lotus ponds or soy bean upland fields. The zoomed image were shown in Figure 8, 9, 10, 11. The higher RVI value showed in warm color, red, yellow in those figures. And the cold color meant lower RVI value. But the relation of RVI value to the biomass in their fields were vague, not clear.

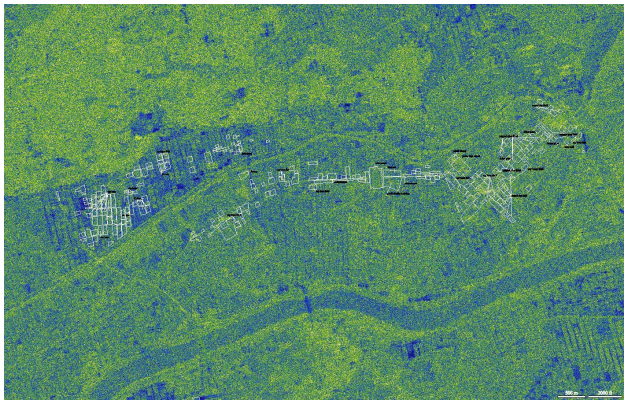


Figure 7. RVI result at the north side of the Tone river and the overlaid-gound-survey-map

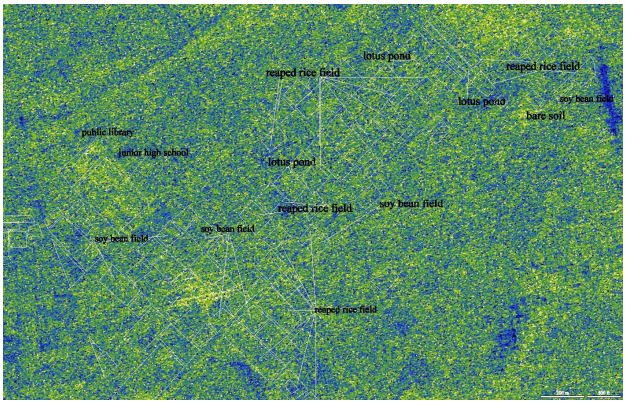


Figure 10. Zooming the RVI result of upper right part of Figure 7. image

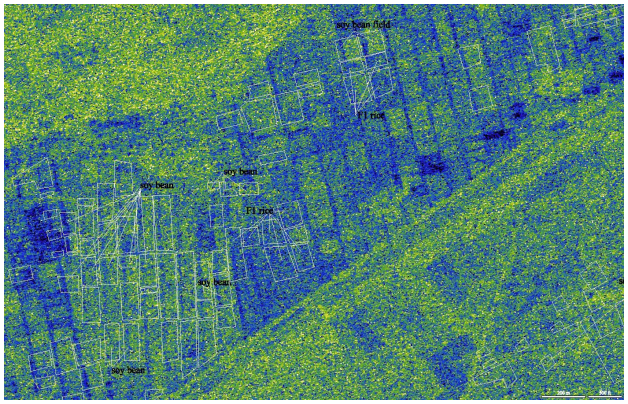


Figure 8. Zooming the RVI result of upper left part of Figure 7. image

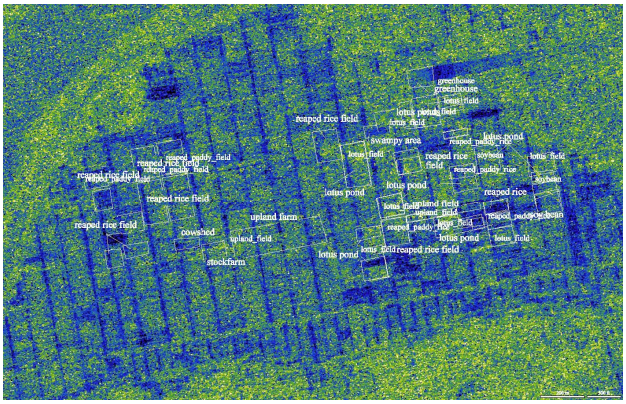


Figure 11. the RVI result of the south side of the Tone river

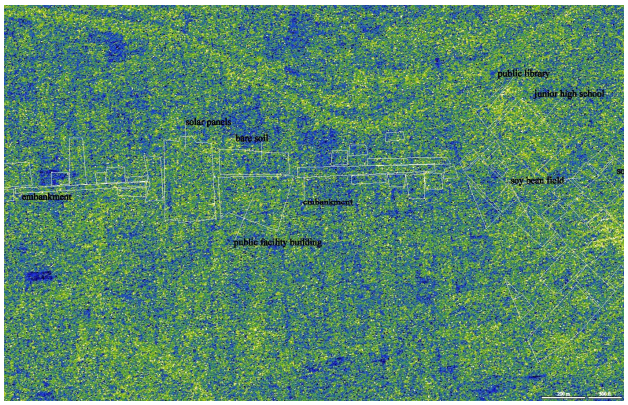


Figure 9. Zooming the RVI result of middle part of Figure 7. image

7. FINDINGS AND DISCUSSION

The Radar Vegetation Index (RVI) was promising and great expectative index for agriculture. Although the RVI result of scatter meter over the rice and soy beans in the near length were good agreement with plantôs biomass in the past research paper (Kim, Jackson, 2012), the RVI from ALOS-2/PALSAR2 satellite radar was not so good.
But this is only one-year and once result. Further research should be desired.

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