PRELIMINARY STUDY ON THE RADAR VEGETATION INDEX (RVI) APPLICATION TO ACTUAL PADDY FIELDS BY ALOS/PALSAR FULL-POLARIMETRY SAR DATA

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ABSTRACT:

Kim and van Zyl (2001) proposed a kind of radar vegetation index (RVI). RVI = 4*min($\lambda 1$, $\lambda 2$, $\lambda 3$) / ($\lambda 1$ + $\lambda 2$ + $\lambda 3$) They modified the equation as follows. (2009) RVI = 8 * $\sigma^0{}_{hv}$ / ($\sigma^0{}_{hh}$ + $\sigma^0{}_{vv}$ + $\sigma^0{}_{hv}$) by L-band full-polarimetric SAR data. They applied it into rice crop and soybean. (Y.Kim, T.Jackson et al., 2012) 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. The author tried to apply the method to actual paddy fields near Tsukuba science city in Japan using ALOS/PALSAR, full-polarimetry L-band SAR data. The staple crop in Eastern Asia is rice and paddy fields are dominant land use. A rice-planting machine comes into wide use in this areas. The young rice plants were bedded regularly ridged line in the paddy fields by the machine. The space between two ridges of rice plants is about 30 cm and the wave length of PALSAR sensor is about 23 cm. Hence the Bragg scattering will appear depending upon the direction of the ridges of paddy fields. Once the Bragg scattering occurs, the backscattering values from the pixels should be very high comparing the surrounding region. Therefore the radar vegetation index (RVI) would be saturated. The RVI did not follow the increasing of vegetation anymore. Japan has launched ALOS-2 satellite and it has PALSAR-2, L-band SAR. Therefore RVI application product by PALSAR-2 will be watched with deep interest.

1. INTRODUCTION

1.1 General Trend of Earth Observation Satellites

Earth observation satellites, which are launched recently, incline toward SAR satellite or the consternation of operation of small satellites which are usually loaded with visible and near infrared band optical sensors. JAXA/ALOS-2 and NASA/SMAP satellite, which are most recently launched, are equipped with the L-band SAR sensor. The specifications of L-band SAR are about 23-24cm wave length. From the viewpoint of agriculture, crop growth monitoring is desired but sometimes cloud cover interrupts ground surface observation. SAR satellite data are welcomed, especially L-band SAR, because of its all-weather data collecting characteristics. Therefore an index for crop growth monitoring using L-band SAR data is important.

1.2 History of RVI

Kim and van Zyl (2001) proposed a kind of radar vegetation index (RVI). RVI = 4*min($\lambda 1$, $\lambda 2$, $\lambda 3$) / ($\lambda 1$ + $\lambda 2$ + $\lambda 3$) They modified the equation as follows. (2009) RVI = 8 * $\sigma^0{}_{hv}$ / ($\sigma^0{}_{hh}$ + $\sigma^0{}_{vv}$ + $\sigma^0{}_{hv}$) by L-band full-polarimetric SAR data. They applied it into rice crop and soybean. (Y.Kim, T.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. METHOD

2.1 Radar vegetation index

ALOS/PALSAR JAXA processing level 1.1 data are converted into backscattering values as following equation.(Isoguchi, Shimada, 2007)

NRCS = 10 * log10 (DN2) + CF
(NRCS: PALSAR normalized radar cross section)
(DN: digital numbers, CF: -83dB=constant)

Every digital number for HH, HV, VV, which mean polarization, were converted into NRCS number. And RVI, radar vegetation index, was calculated by the following equation.
RVI = (8 * ůHV) / (ůHH + ůVV + 2 * ůHV)
(RVI: radar vegetation index)

2.2 RVI calculation procedure

ALOS/PALSAR processing level 1.1 data

↓

Calculation of backscattering value

NRCS = 10 * log10 (DN2) + CF

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RVI = (8 * ůHV) / (ůHH + ůVV + 2 * ůHV)

Figure 1. Flow of RVI calculation

3. SATELLITE DATA

Satellite data for this analysis are the following 4 days. From April to September, the major crop, paddy rice, is just the growing season in Japan. These data are full-polarimetry.

SCNID	OBSSDATE
ALPSRP063230710	2007/4/2 12:53
ALPSRP069940710	2007/5/18 12:53
ALPSRP022970710	2006/6/30 12:53
ALPSRP029680710	2006/8/15 12:54

4. EXPERIMENT FIELD

The experimental 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 wheat fields or lotus paddy fields scattered among paddy fields in this area. Lotus roots are a kind of foodstuff of Japanese dishes. Geographical features are flat and somewhere its drain is bad.

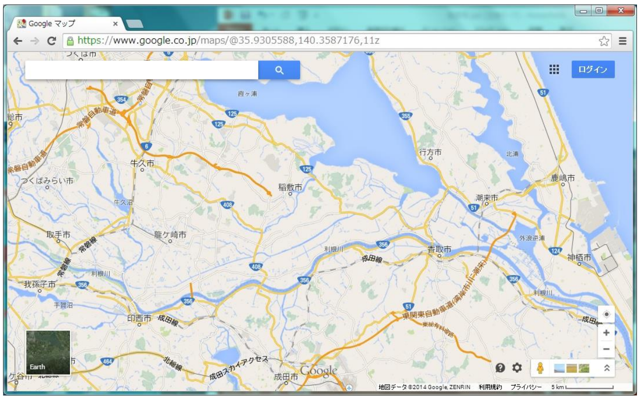

Figure 2. Map of the experiment field

5. RESULT

Figure 3,4,5 and 6 shows RVI value which is converted from 0-255, cold colour to warm colour. In growth of paddy rice plants, the colour of paddy fields changed to warm colour. In this region, paddy rice was transplanted in April, and was reaped in August or September. If the year changes, the land use of paddy rice is almost not changed. Though the year of the data acquisition is different, it is assumed to be the same land use. But some areas always indicate red colour. That should mean the RVI value reached saturation.

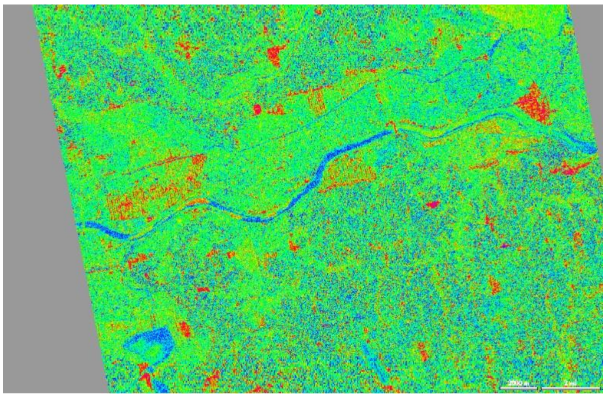

Figure 3. RVI on April 2^{nd}, 2007

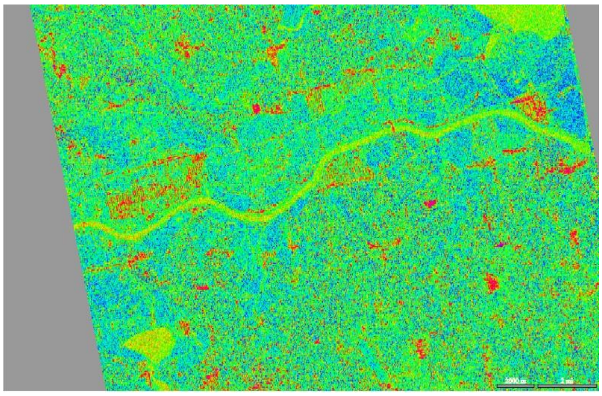

Figure 4. May 18^{th}, 2007

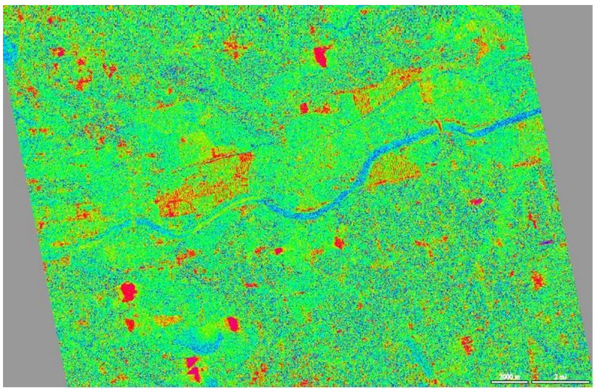

Figure 5. June 30^{th}, 2006

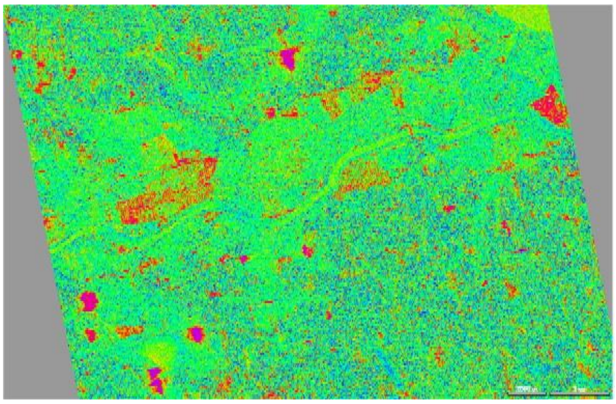

Figure 6. August 15th, 2006

Results of conventional full-polarization SAR data analysis are indicated the following figures.

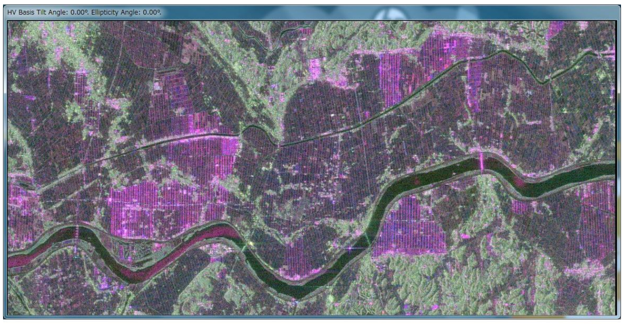

Figure 7. Pauli decomposition (R:HH G:HV B:VV)

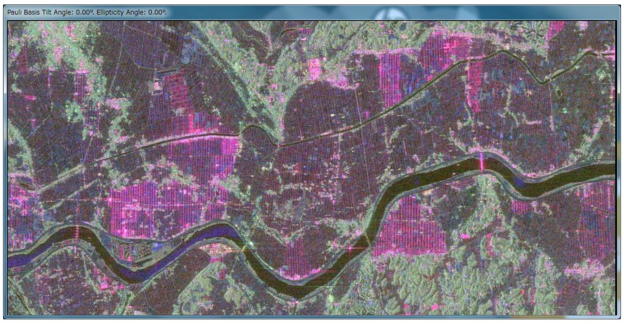

Figure 8. Pauli basis (R: HH-VV G: HV B:HH+VV)

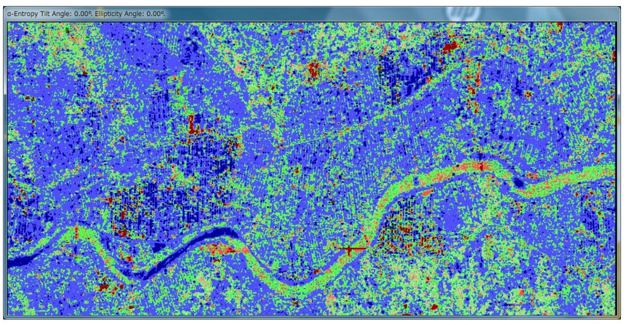

Figure 9. α , Entropy decomposition

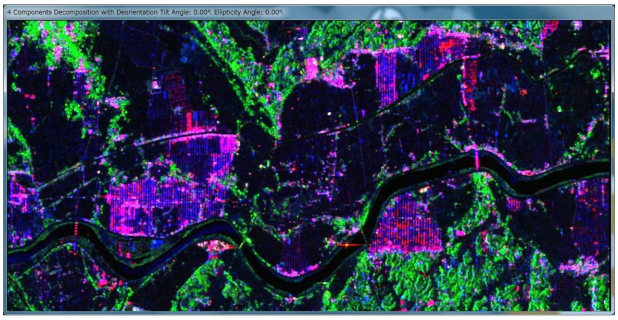

Figure 10. 4-component decomposition

6. CONCLUSION

(1) Kim and Jackson pointed out that Radar Vegetation Index is highly correlated with NDVI. But the width of ridges of rice plants in the Japanese paddy fields is systematic arrangement and nearly equal with wavelength of L-band SAR. Then the Bragg scattering will occur when the direction of ridges is parallel to the azimuth direction of satellite. The RVI value will be saturated.
(2) Except for the Bragg scattering region, it will be possible to know the growing stage of rice plants.
(3)As the ALOS-2/PALSAR2 is L-band SAR, it will be possible to know the paddy rice grow in Asian countries.

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