Basic study on extracting large paddy areas based on the spatial purity of the low spatial resolution satellite data

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1. Introduction

Rice is the stable food for 50% of world's population. Moreover, rice agriculture revenue has been a main income of many South-east Asian countries which annually produce 25% rice production of the world [1]. Therefore, paddy land is one of the most important land use types in the Earth, which is changing significantly under the influence of human activities. Thus, monitoring of paddy land information is very valuable in agricultural management, planning and decision making to ensure the long term sustainability of agriculture.

Remote sensing technology has been applied to extract paddy land information. To properly use satellite Earth observation for large paddy areas monitoring, high temporal revisit frequency over vast geographic areas is necessary. However, this often limits the spatial resolution that can be used. Therefore, finding the method to extract large paddy areas using low spatial resolution satellite data is very useful in present. This study aims to extract large paddy areas based on a spatial purity of a low spatial resolution satellite data such as Terra/Aqua MODIS data.

2. Data description and target region

Landsat 8 OLI images (Path: 108; Row: 34) and DEM data were used to identify paddy area in 30m spatial resolution. Landsat 8 OLI images which correspond to transplanting period (25^{th} May, 2015) and growing period (12^{th} July, 2015) of rice. DEM of 50m mesh data created by the Geospatial Information of Authority (GSI). The field obsevation region is a part of paddy area that located at the west side of the Shinano river in Nagaoka city. The target area is Niigata plain.

3. Methodology

In order to extract large paddy areas through the calculation of spatial purity of the low spatial resolution satellite data, first of all, this study has calculated spatial purity of paddy areas using 30m spatial resolution. Paddy areas are defined as areas with increasing vegetation growth seasonally and are flat terrain regions.

According to the seasonal change of the spectral characteristics of paddy area (such as the spectral of paddy area is similar to the water surfaces' in transplanting period and paddy areas are cover by rice plants in growing period), the vegetation index (VI) was calculated to extract increasing vegetative growth pixels by following formula:

$$\mathrm{VI} = \frac{\mathrm{NIR\,2} - \mathrm{R2} - \mathrm{NIR\,1}}{\mathrm{NIR\,2} + \mathrm{R2} + \mathrm{NIR\,1}} \quad (1)$$

Where: NIR2 and R2 are near infrared reflectance and red reflectance at growing period respectively; NIR1 and R1 arre near infrared reflectance and red reflectance at transplanting period respectively.

Then, based on field observation data, the threshold of VI value was determined and vegetation pixels are extracted.

Thereafter, flat plain regions are extracted by using digital elevation mode (DEM) of 50m mesh data. The region where its slope is less than 5 degree is flat terrain region.

After deciding paddy pixel, the spatial purity was calculated after the resolution was be transformed from 30m to 10m pixel spacing.

4. Result

4.1. Extracting vegetation region from Landsat 8 OLI

The threshold to find out vegetation pixel was examined based on field observations of cropping/non cropping farmland areas. Fig.1 shows VI values of cropping/non cropping farmland area in field observation region. The results present that all VI values of cropping paddy areas in field observation region are greater than 0.0 (from 0.008 to 0.393). On the other hand, all VI values of non cropping paddy areas in field observation region are less than 0.0 (from -0.269 to -0.029). Therefore, the threshold of VI value to extract cropping paddy pixel is 0.0. However, this result included cropping paddy pixels and noise pixels (because shadows of mountain).

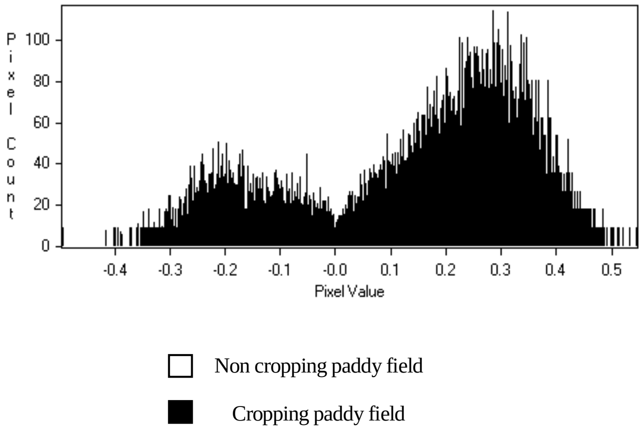

Fig.1 Histogram of VI value of non cropping paddy field and paddy field

4.2. Extracting flat terrain region

To remove noise pixels, digital elevation model (DEM) has been used to detect flat terrain region where its slope is less than 5 degree. To extract paddy pixel, we overlapped vegetation region image and flat terrain region image.

4.3. Calculating spatial purity

In order to calculate spatial purity of paddy area, this study has used spatial filter with the kernel dimensions is 25x25 which corresponds to one MODIS pixel in 250m spatial resolution. Fig.2 shows spatial purity map of Niigata plain.

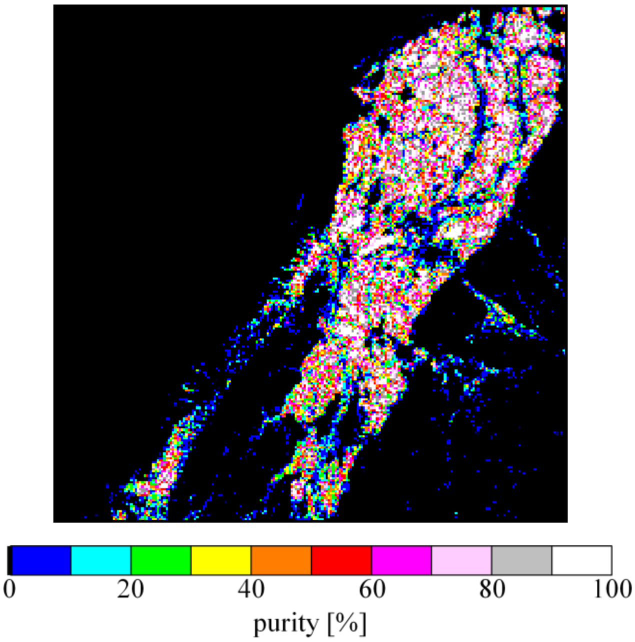

Fig.2 Spatial purity map

4.4. Extracting large paddy area

To extract large paddy area, this study chose the spatial purity is 80% and 90%. The results are shown at fig.3.

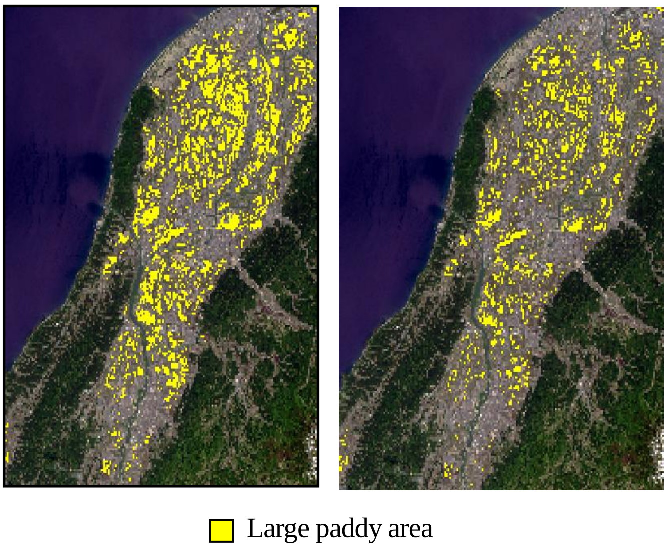

Fig.3 Large paddy area where purity is greater than 80% (left) and 90% (right)

5. Conclusion

This study's result can be able to apply to extract large cropping paddy areas using low spatial satellite data such as Terra/Aqua MODIS data.

REFERENCES

1. C.F. Chen, *Delineating rice cropping activities from MODIS data using wavelet transform and artificial neural networks in the Lower Mekong countries*, 2012.