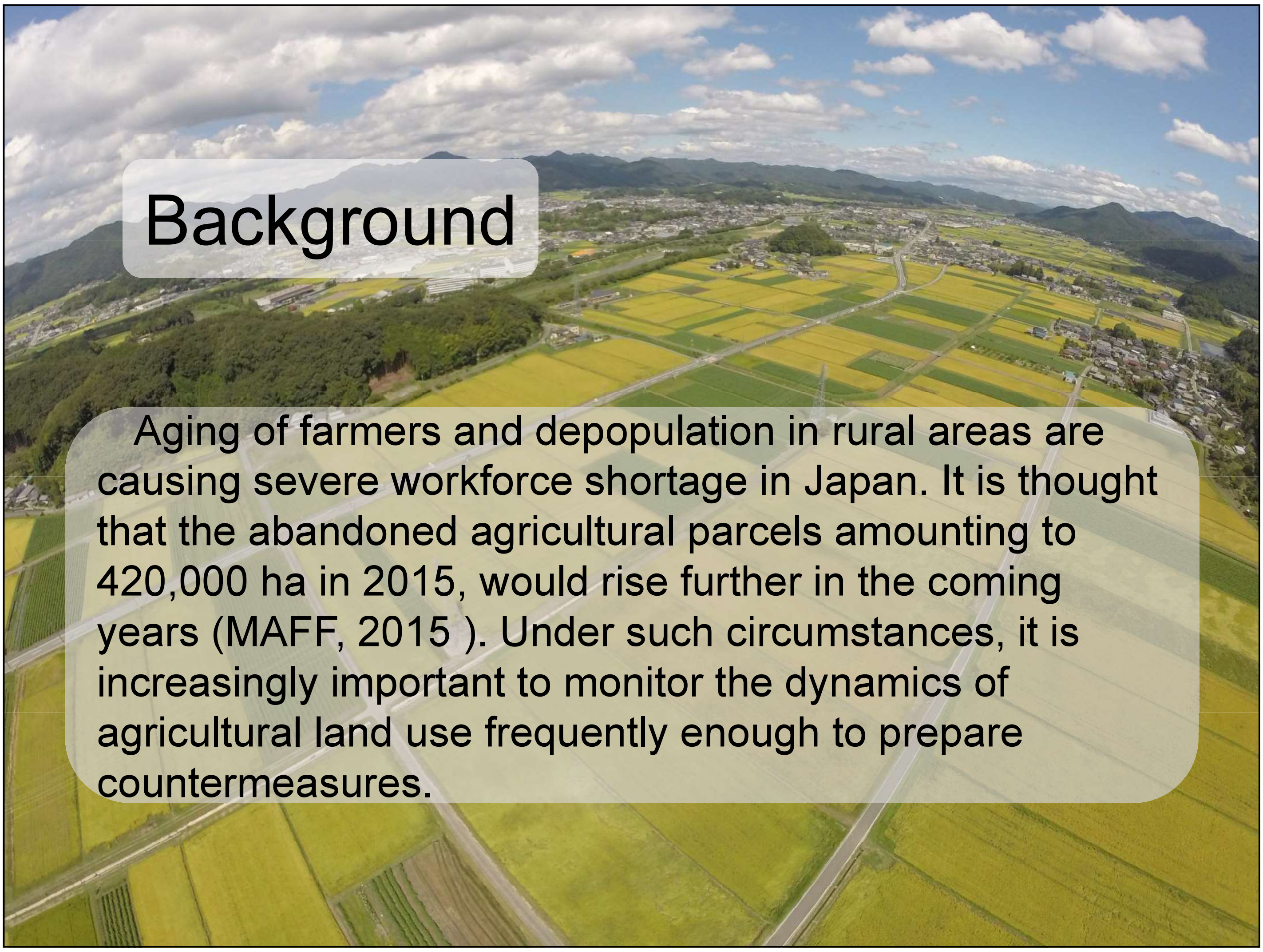
Land use classification of small agricultural parcels using multiple synthetic aperture radar images

Takanori Nagano	Kobe University
Abudukeremu Ainalibanua	Kobe University
Yoichi Fujihara	Ishikawa Prefectural University
Natsuki Yoshikawa	Niigata University



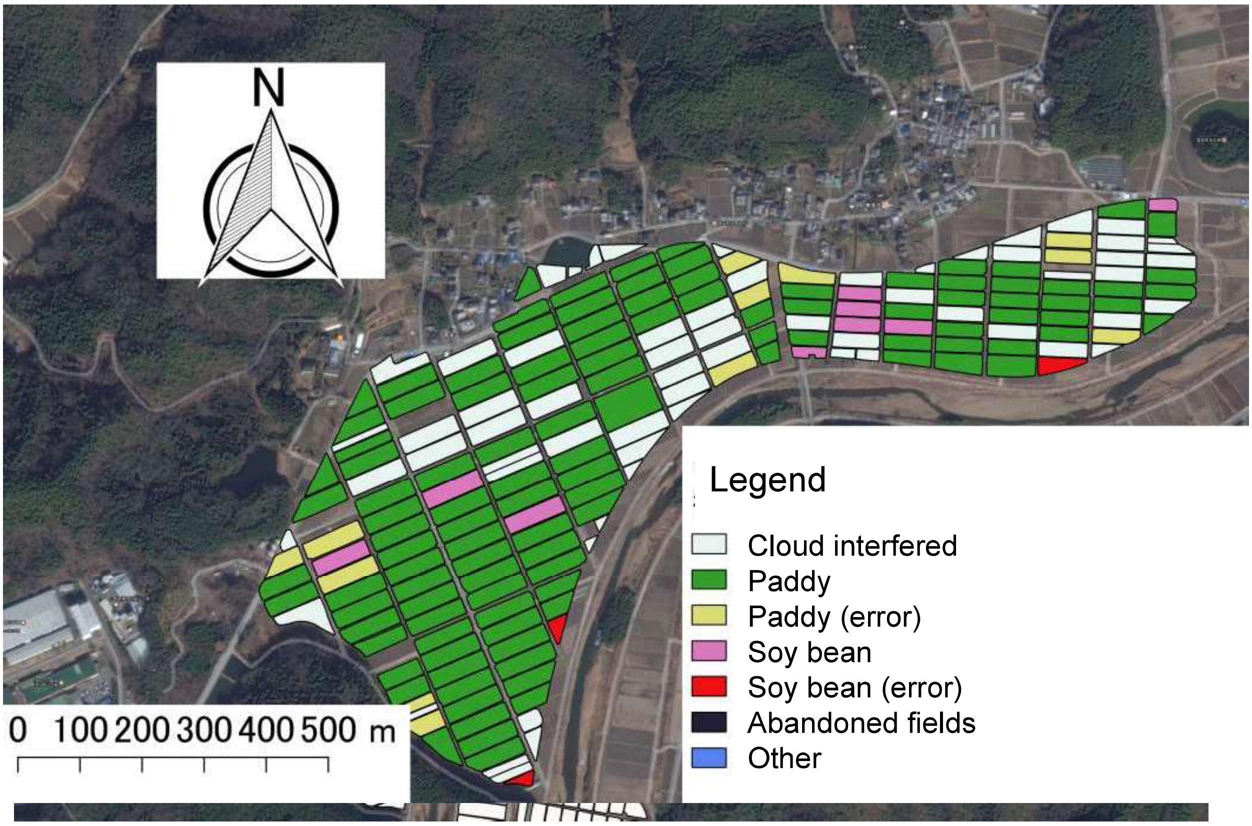
Background

Aging of farmers and depopulation in rural areas are causing severe workforce shortage in Japan. It is thought that the abandoned agricultural parcels amounting to 420,000 ha in 2015, would rise further in the coming years (MAFF, 2015). Under such circumstances, it is increasingly important to monitor the dynamics of agricultural land use frequently enough to prepare countermeasures.

Research Objective

Develop methodology to realize low-cost plot-to-plot classification for small Japanese agricultural parcels.

Plot-to-plot classification



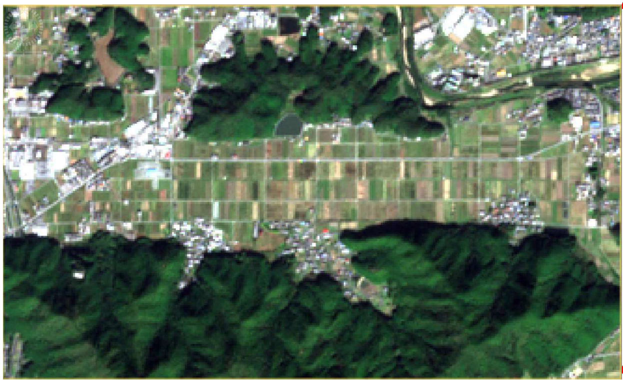
A trade-off between accuracy and cost

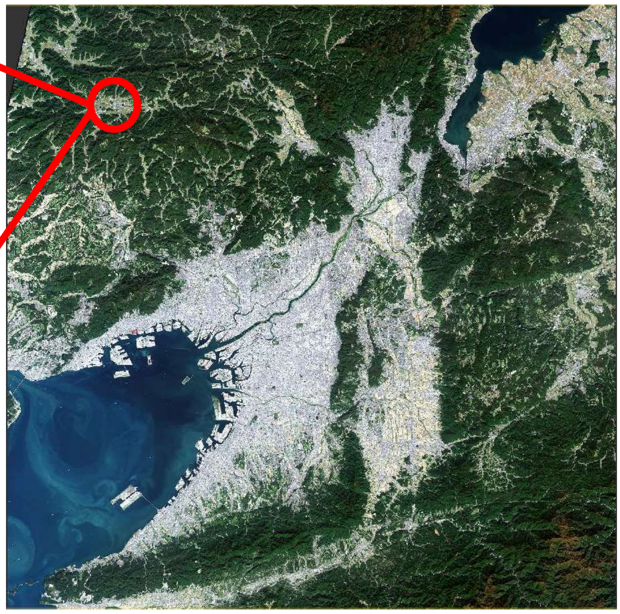
Agricultural parcels in Japan are small (typically less than 0.3 ha) and therefore plot-to-plot classification requires high resolution satellite imagery which is expensive. The areal coverage of such image is small which further increases the cost if regional classification is intended.

WorldView-2 with a ground resolution of 46 cm（Ref：NTT DATA）

Use of mid-resolution open data

There are increasing varieties of open access satellite images with medium resolution (10-30 m). Optical sensor images such as Landsat and Sentinel-2 have limited image availability during monsoon season.

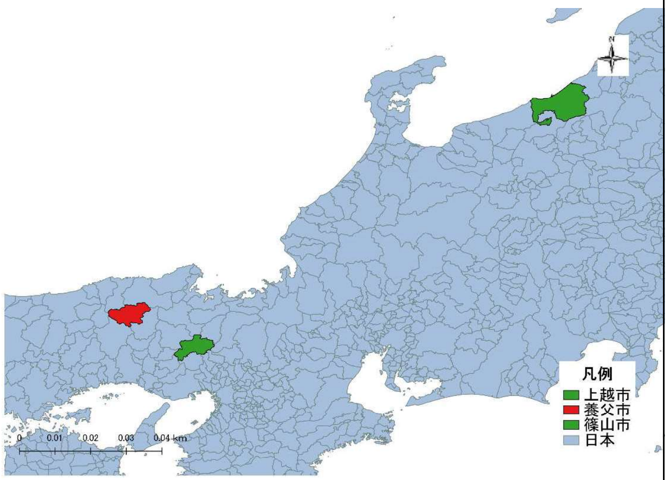




Right： Sentinel-2 image (whole)
Left ： A zoom-in to agricultural parcels

Study areas

3 different regions in Japan

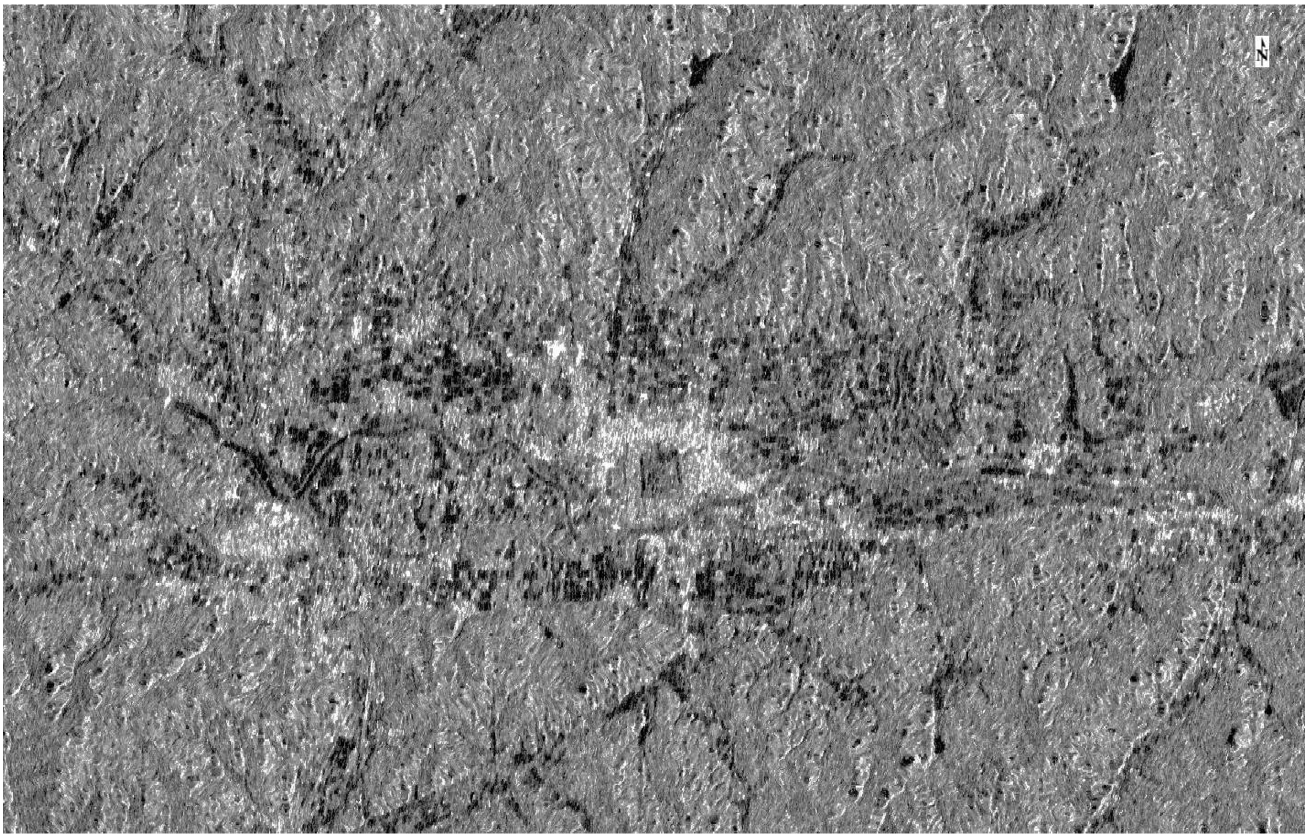


Location	Main land use	Total Plot number	Observed plots (average size)	
			2016	2017
Sasayama, Hyogo	Rice, soy bean etc.	40166	868 (20.1a)	1715 (15.8)
Yabu, Hyogo	Rice, vegetable abandoned fields	9869	–	2910 (8.95)
Joetsu, Niigata	Rice, soybean, backwheat	12948	1085 (27.4)	2859 (18.68)

To enable punctual observation unaffected by Monsoon climate

- Use Synthetic Aperture Radar (SAR) images instead of optical sensor images.
- SAR images are not affected by cloud
- SAR images measures roughness of the land surface.
- The rougher the surface, the portion of radar which is scattered by the ground object which comes back to the radar (Backscatter coefficient) increases.
- The degree of scattering is dependent on the frequency of magnetic waves.

Optical image（Sentinel-2）
Sasayama city, Oct 17. 2016



SAR image（Sentinel-1）
Sasayama city　May 28, 2016

C-band and L-band SAR

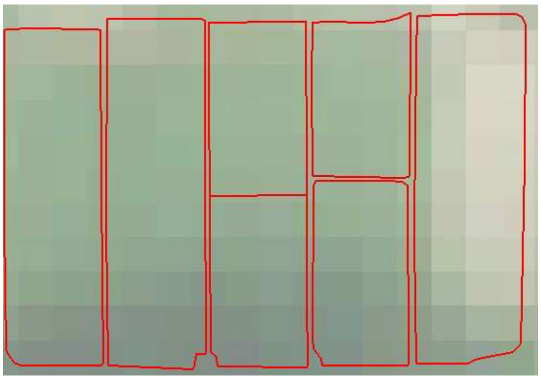
Type	Name	Frequency	Resolution	Polarization	Revisit
C-band	Sentinel-1	5.405 GHz	5 x 20 m	VV	6 days
L-band	Alos-2	1.27　GHz	3 x 3 m	HH	14 days

Preprocessing

- Use of raw backscatter coefficient from single polarization
- Software: ENVI SARscape（Harris Geospatial）
- No multilooking, Single image filtering（Refined Lee）
- Geoid-corrected Alos World 3D (DSM) used for geocoding

To accurately choose pixels representing the feature of the plot

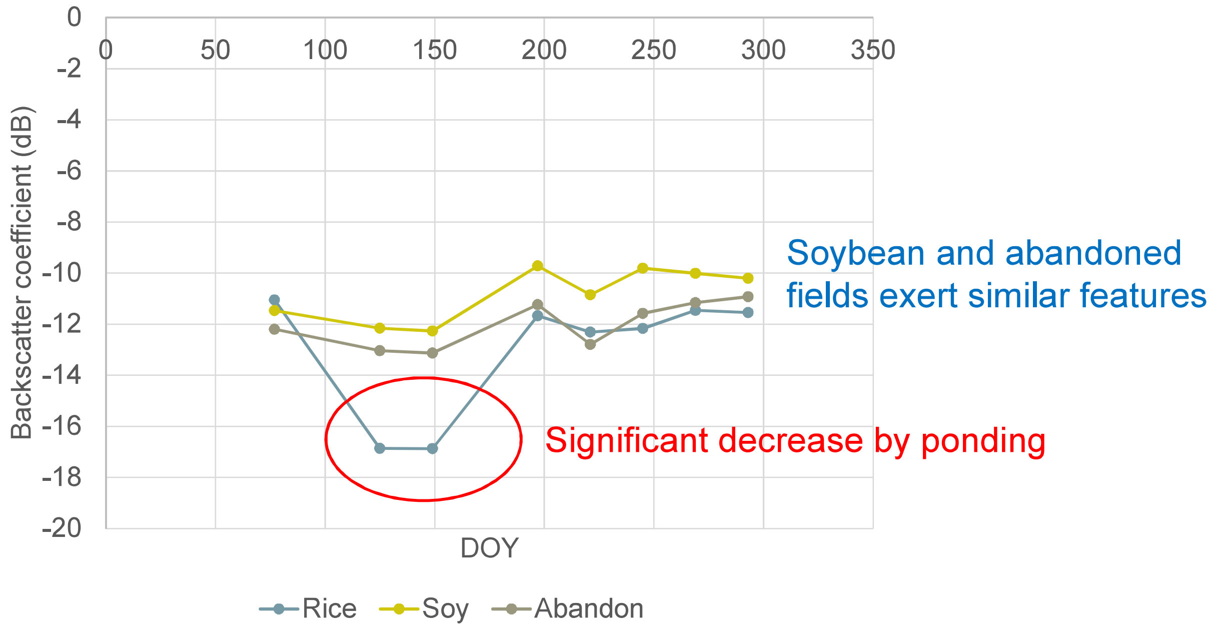
- Use GIS shapefiles of agricultural parcels provided by the Land Improvement District Union of each prefecture in Japan.
- Superimpose on SAR images and choose median value of pixels included in each plot.



Plot outline data superimposed on a raster image.

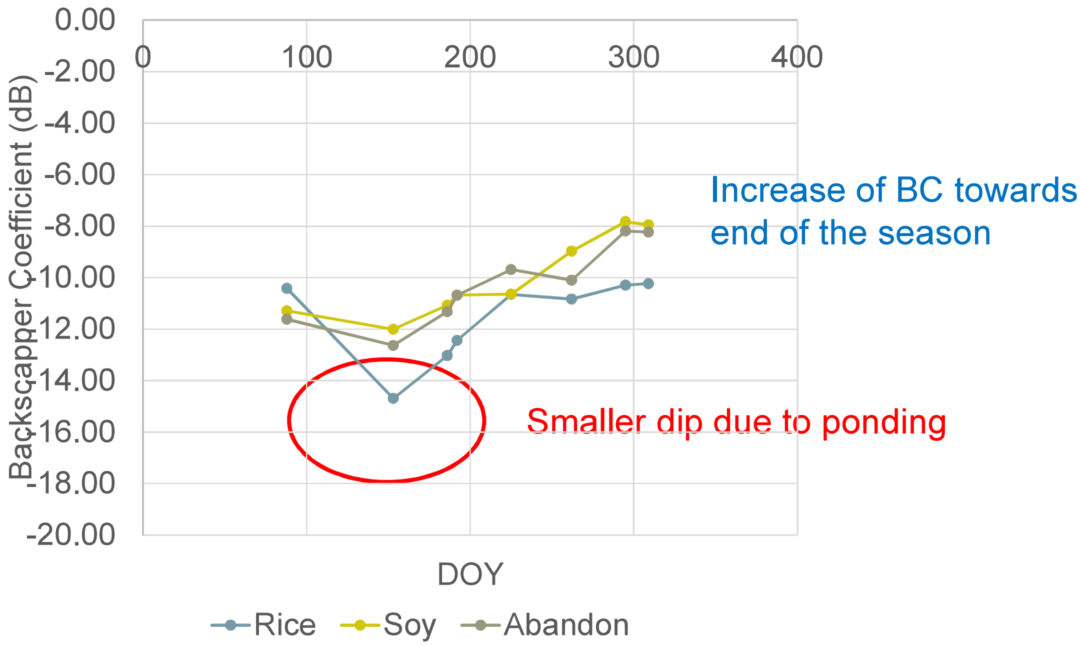
Results and discussions

Change of backscatter coefficient from different land use (Sentinel-1,C-band)



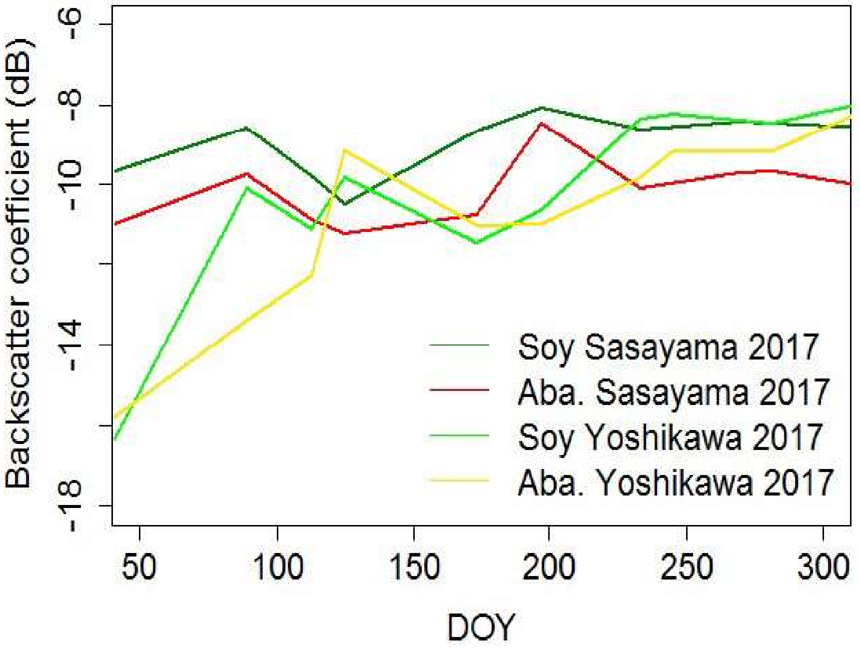
Sasayama, Hyogo, 2016

Change of backscatter coefficient from different land use (Alos-2,L-band)



Sasayama, 2016

Difficulty in separating soy bean fields and abandoned fields



BC do not capture any significant difference between soy bean and abandoned fields

Similarity and difference between L-band and C-band

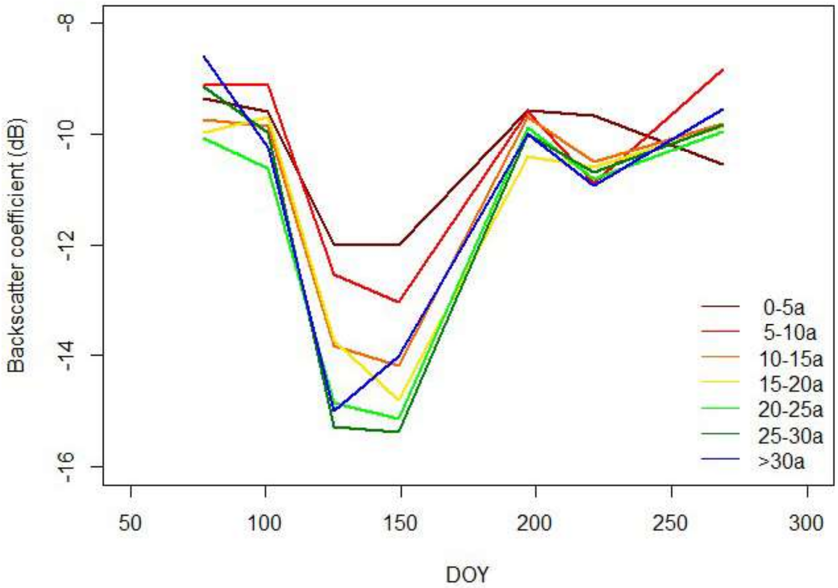
Similarity

- BC from paddy fields become lower due to ponding in the beginning of the season (May). It continues until late June when rice grows taller

Difference

- C-band show similar change in BC in different regions
- L-band seems to be sensitive to soil moisture content
- L-band seems to be sensitive to increase in biomass

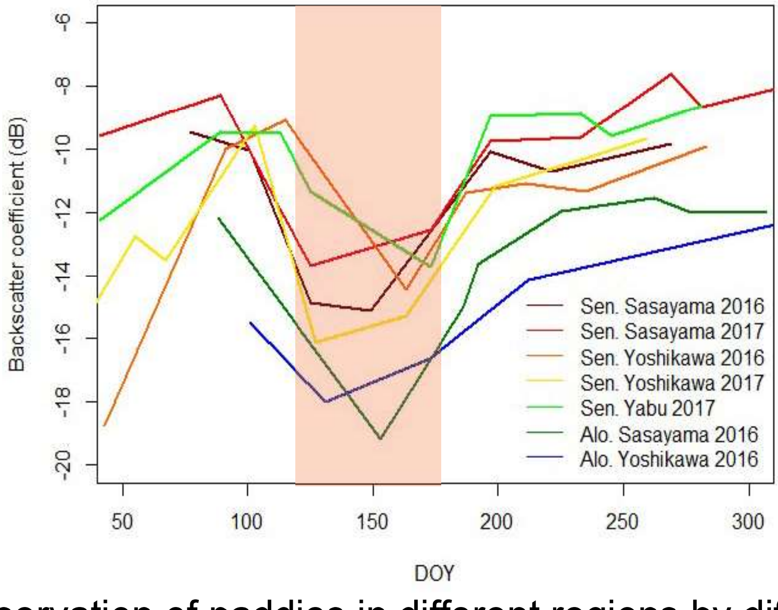
Effect of plot size on BC in paddies



Change of backscatter coefficient in paddies of different sizes observed by Sentinel-1 in Sasayama, 2016

In plots smaller than 0.15 ha, signature is weakened

Optimum period for paddy detection



Observation of paddies in different regions by different SARs

From mid-May to mid-June, drop of BCs are significant

Comparison of paddy classification accuracy between C-band and L-band

Method

3 step decision tree model for best estimate

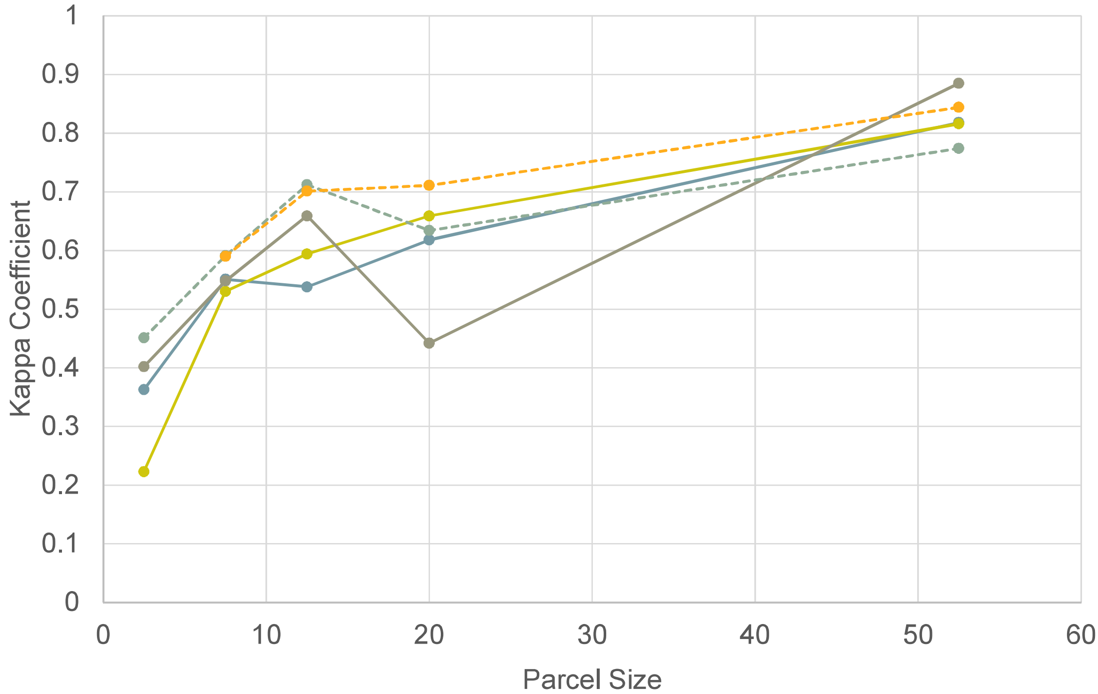
C-band（Sentinel-1)

3 out of 5 bands between mid-May and mid-June used

L-band (Alos-2)

3 images available between late April and late June were used

Accuracy of paddy detection by C-band and L-band SAR images



Kappa coefficient

less than 0.4：bad, 0.41~0.60：fair, 0.61~0.80：good,0.81~1：exellent

Conclusion

- Both C-band and L-band SAR are useful in classifying paddy and non-paddies.
- For fields larger than 0.15 ha, accuracy is reliable with observations in the beginning of the season.
- L-band was more accurate in classifying fields smaller than 0.10 ha due to higher resolution.
- Neither were able to detect difference among non-paddy land use (soy bean and abandoned fields).