Innovating on Wide-ranged Ecology Research by Hyper-sensor

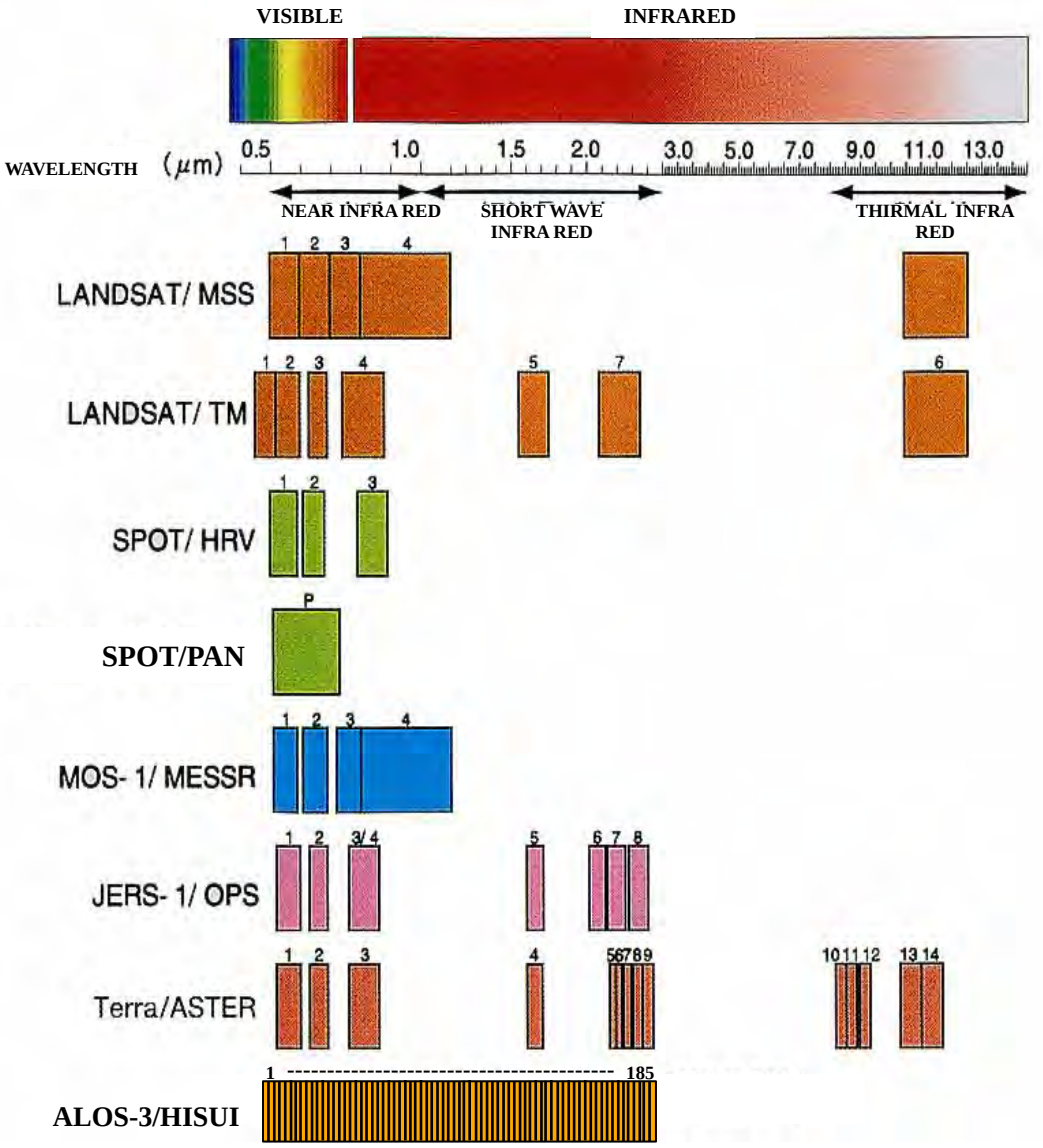
“Evaluation of the High-Carbon Reservoirs: Tropical Peatland by Integrated MRV System”

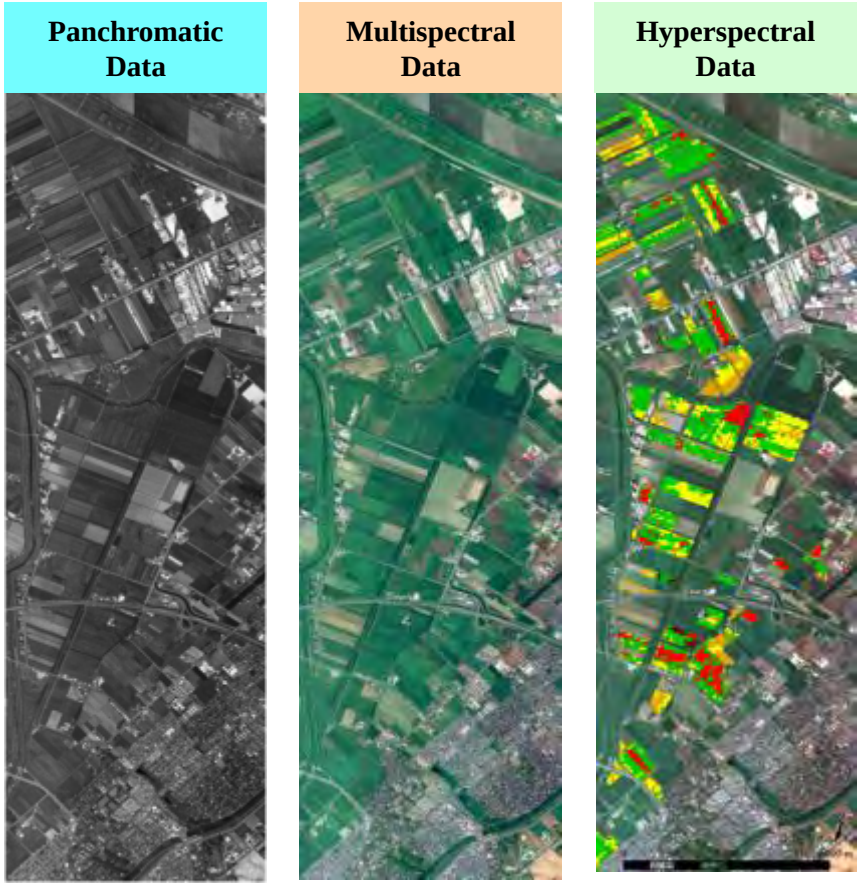
Kazuyo Hirose[*1], Tomomi Takeda[*1], Seido Onishi[*2], Osamu Kashimura[*1], Takashi Ohki[*3], Taichi Takayama[*3], Hozuma Sekine[*3], Mitsuru Osaki [*4], Shunitsu Tanaka [*4], Yustiawati [*4], Gao Yan[*4], Hendrik Segah [*5], Linda Wulandari [*5]

and Muhammad Evri [*6]

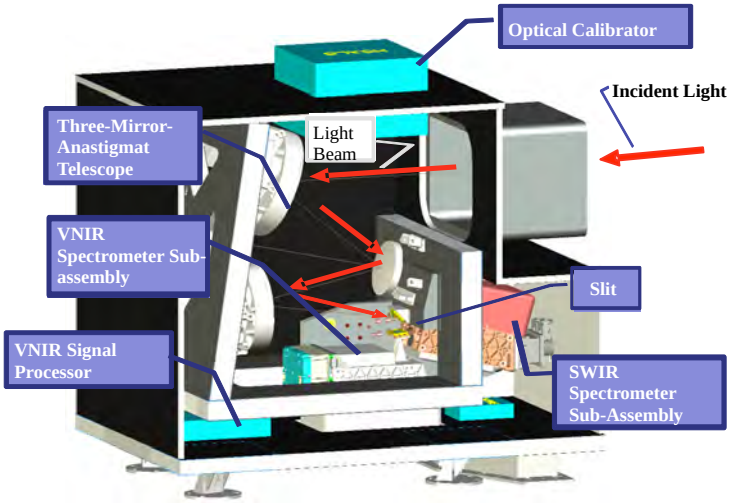
[*1] Japan Space Systems, [*2] Asia Air Survey, [*3] Mitsubishi Research Institute, Inc., [*4] Hokkaido University, [*5]University of Palangka Raya, [*6]Agency for the Assessment and Application of Technology, Indonesia (BPPT)

What is Hyperspectral , Multispectral data ?

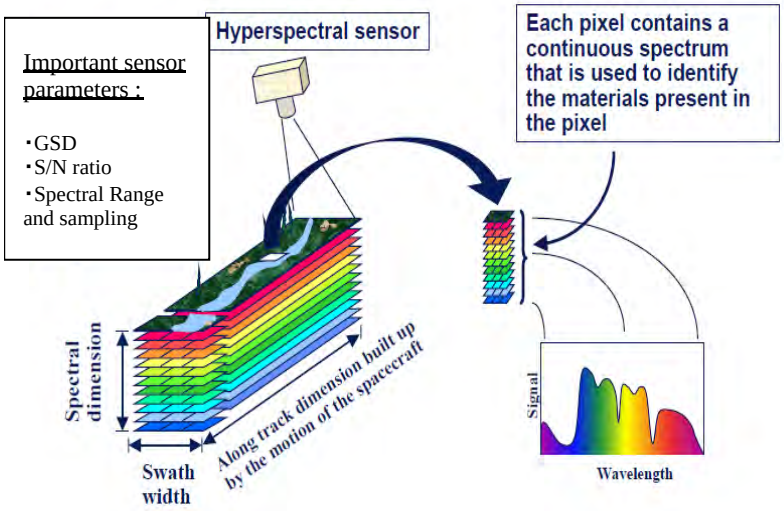




Hyperspectral data provides vast amount of information.



HISUI **Hyperspectral** Imager

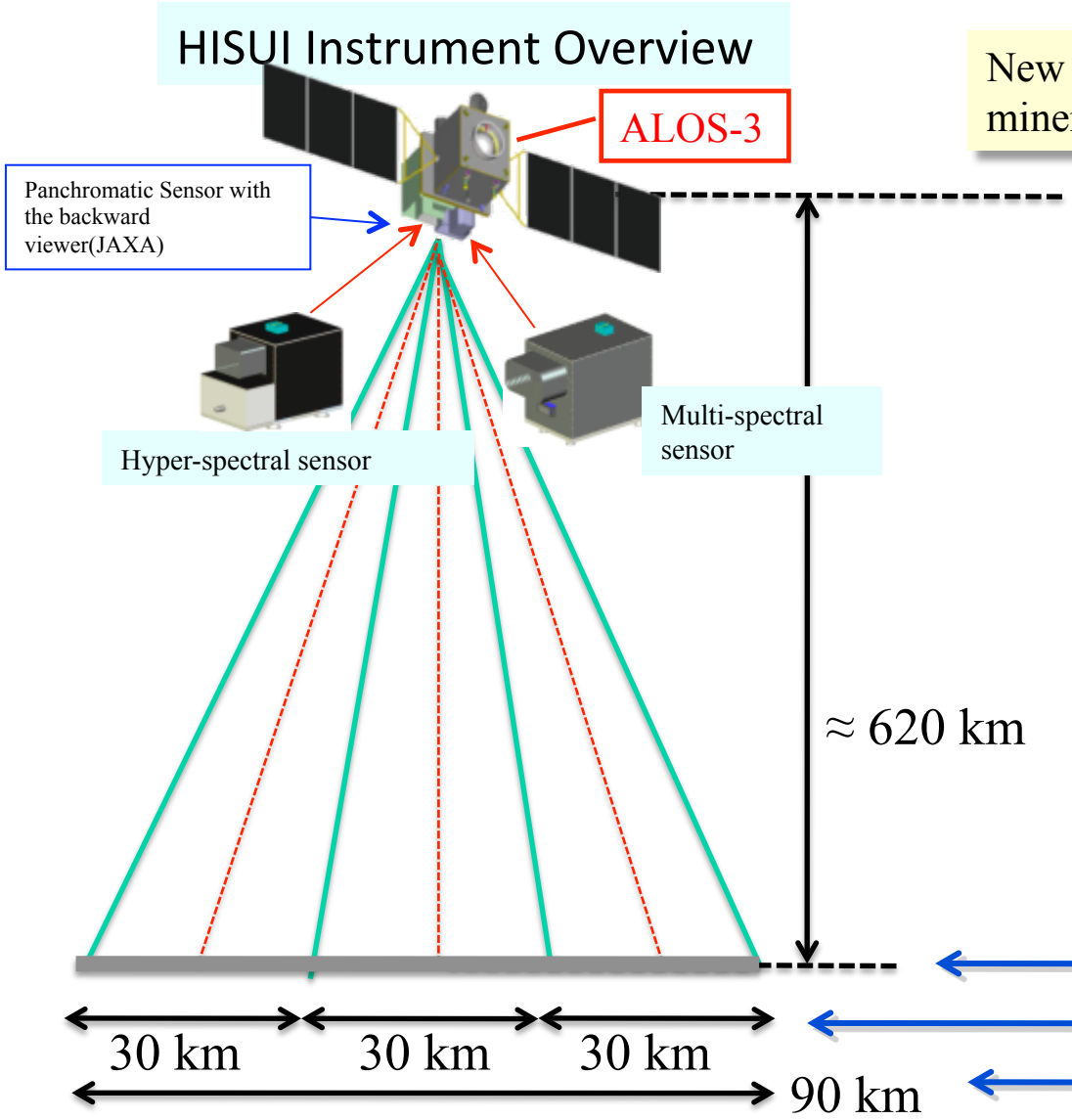


- METI is developing a spaceborne hyperspectral imager, called **HISUI**.
- It will be utilized for various fields; oil/gas and mineral exploration, agriculture, forestry and environmental monitoring including peatland.

		Hyperspectral Imager	Multispectral Imager
Spatial Resolution		30 m	5 m
Swath		30 km	90 km
Spectral	#Band	185 VNIR:57 SWIR:128	4
	Coverage	0.4-2.5 μm	0.45-0.89 μm
		VNIR: 0.4-0.97 μm SWIR: 0.9-2.5 μm	Band1:450-520, Band2:520-600 Band3:630-690, Band4:780-890
	Resolution	VNIR: 10 nm SWIR: 12.5 nm	
S/N		≥ 450 @ 620 nm ≥ 300 @ 2100 nm	≥ 200
Modulation Transfer Function		≥ 0.2	≥ 0.3
Dynamic Range		12 bits	12 bits
Pointing		±2.75 ° (±30 km)	-

HISUI Development

Data Application and Ground Data system



New challenge to more detail and precise information for mineral distribution, vegetation and environmental issues

Parameter		Requirement	
		Hyperspectral Imager	Multispectral Imager
Spatial	Resolution	30m	5 m
	Swath Width	30km	90 km
Spectral	Bands	-185	4
	Range	0.4 ～ 2.5μm	0.42～0.90μm
	Resolution	10nm (VNIR) 12.5nm (SWIR)	——
D. Range		≥ 10 bits	≥ 8 bits

Launch is scheduled in 2016 or later

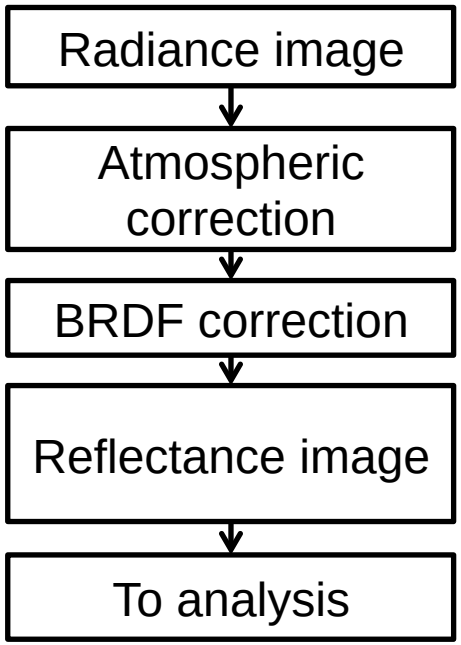
HISUI Hyperspectral Imager has a cross-track pointing function to tilt the whole instrument and covers the eastern and the western parts of 90-km swath of HISUI Multispectral Imager.

HISUI : Hyper-spectral Imager SUIte

- Flight date
  - Test site 1: 2011/7/16
  - Test site 2: 2011/7/15, 7/16
- Corrections
  - Atmospheric correction
  - BRDF correction

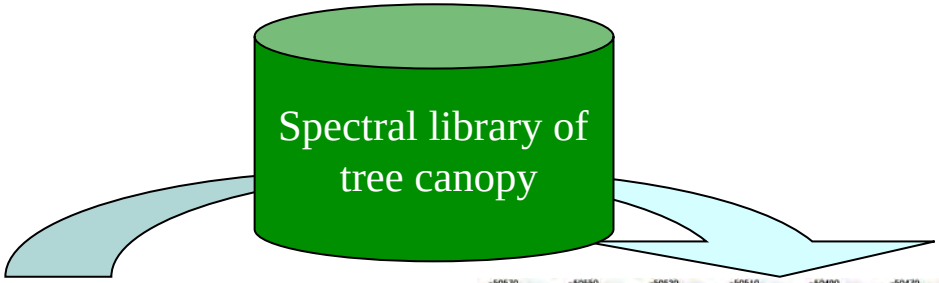
HyMap Specification

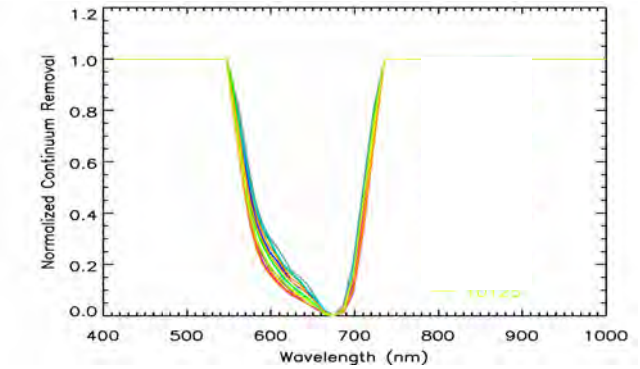
Spatial resolution	4.2m
Spectral range	440～2,480nm
Spectral resolution	
440～1,350nm	15nm
1,400～1,800nm	13nm
1,950～2,480nm	17nm
Band number	126

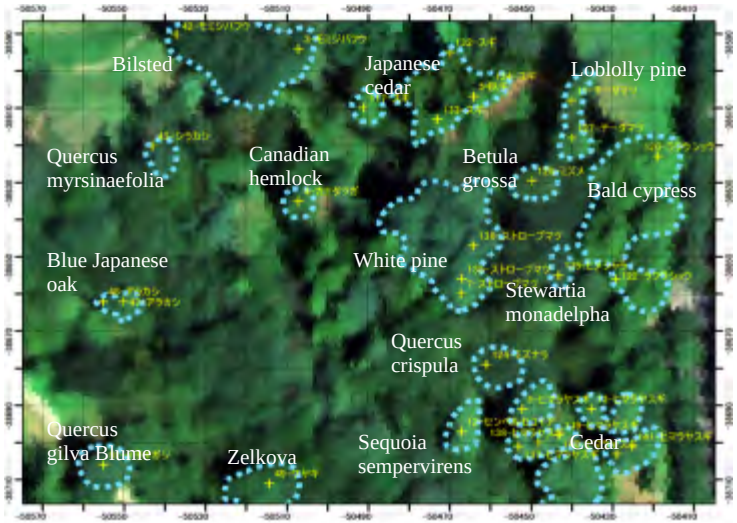


1. Biodiversity Mapping

Focusing to Chlorophyll absorption range (Red edge), tree species are classified in detail. Combined field survey and airborne hyperspectral imagery, spectral library of tree canopy was made and used for tree classification.

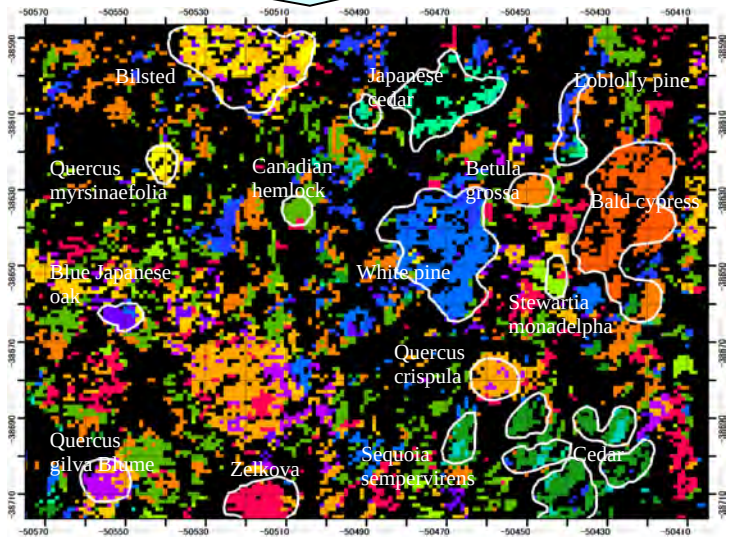






20m

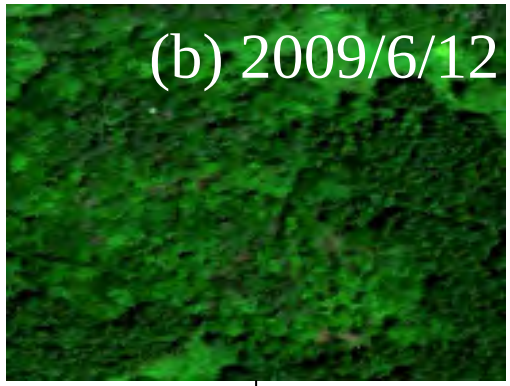
Site : Tokyo, Japan
Data : CASI (2004/9/1)
[413-1053nm, 72bans, 1x1m]

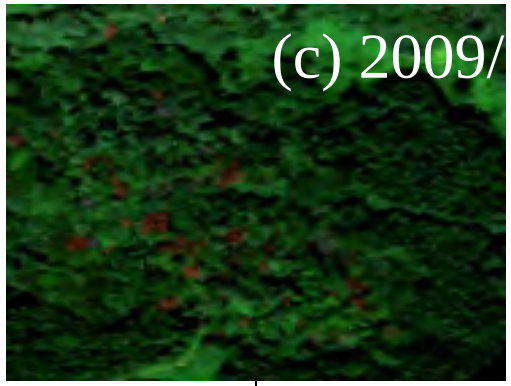


Broadleaf trees are classified into species.
It's difficult for multispectral data.

2. Forest Degradation Mapping

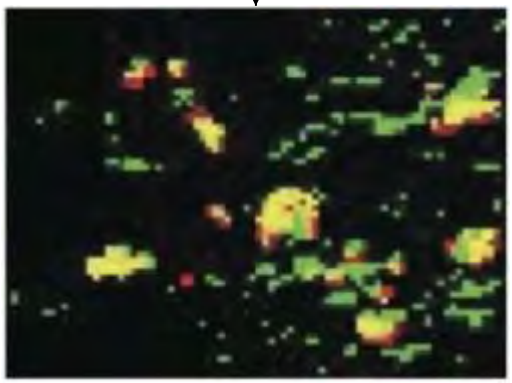
Using NDWI as a indicator of water stress, blast disease of oak tree is detected in the early stages.
This result shows that the analysis using hyperspectral data can monitor the health condition which multispectral analysis (or visual examination) can not detect.





Extract water stressed trees using NDWI（NDWI<-0.2）

Extract dead trees



Validation of extraction result

Red：Dead trees in Fig.(c)
Green：water stressed trees in Fig.(b)
Yellow：Corresponding area of estimated water stressed trees in June and dead tress in August.

Normalized Difference Water Index（NDWI）

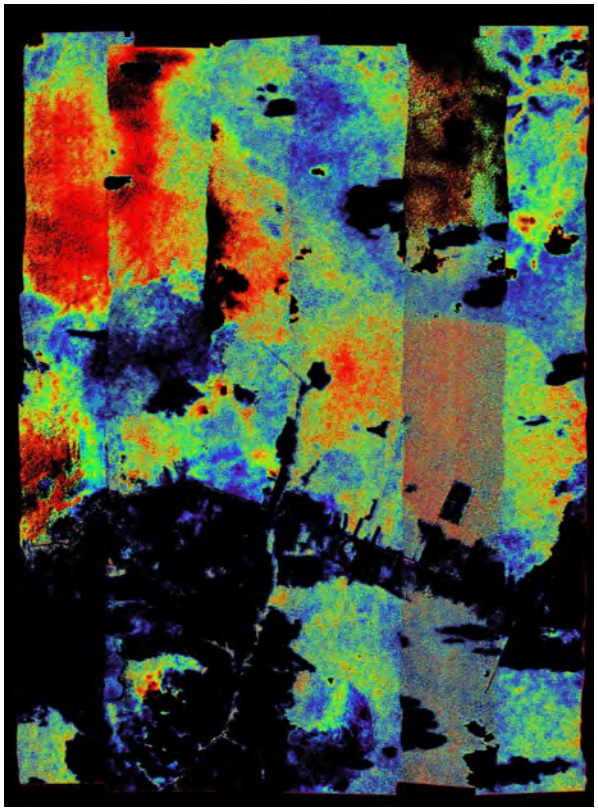
$$NDWI = \frac{NIR - SWIR}{NIR + SWIR}$$

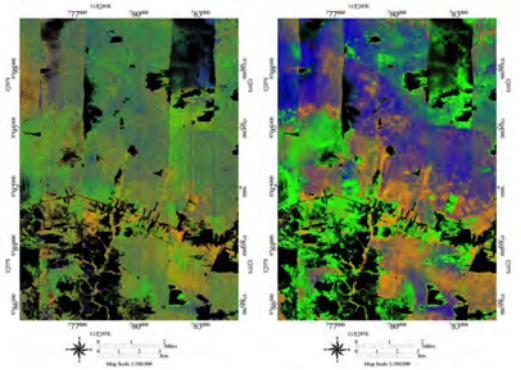
（NIR：880nm，SWIR：1240nm）

3. Biomass Mapping

Result

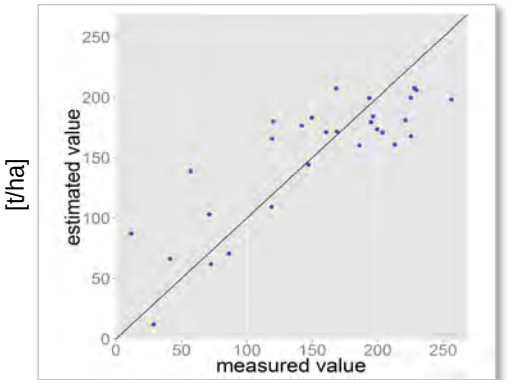
Biomass Estimation





Forest Classification Map

- The biomass estimation model was developed for each quadrat by LASSO regression using reflectance data (86 bands) and texture data (GLCM: Gley Level Co-occurrence Matrics).

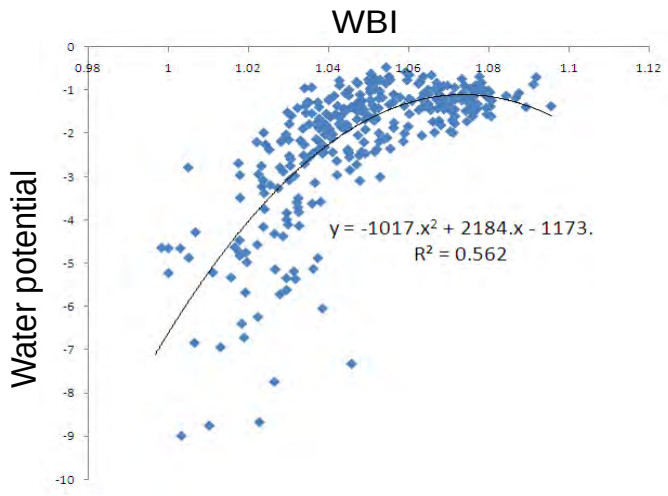


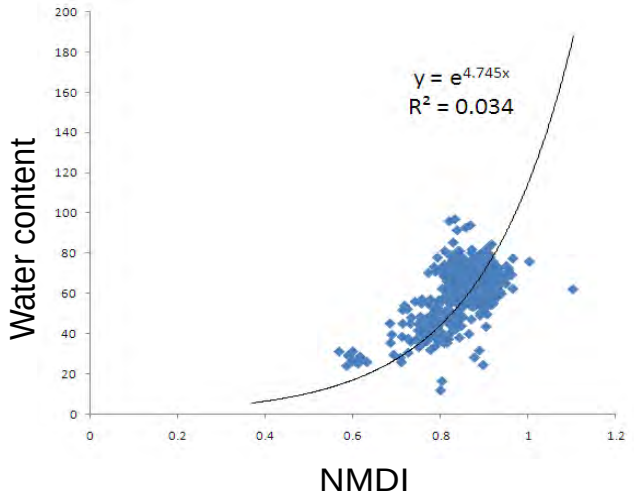
Biomass Estimation Model

4. Water Potential Mapping

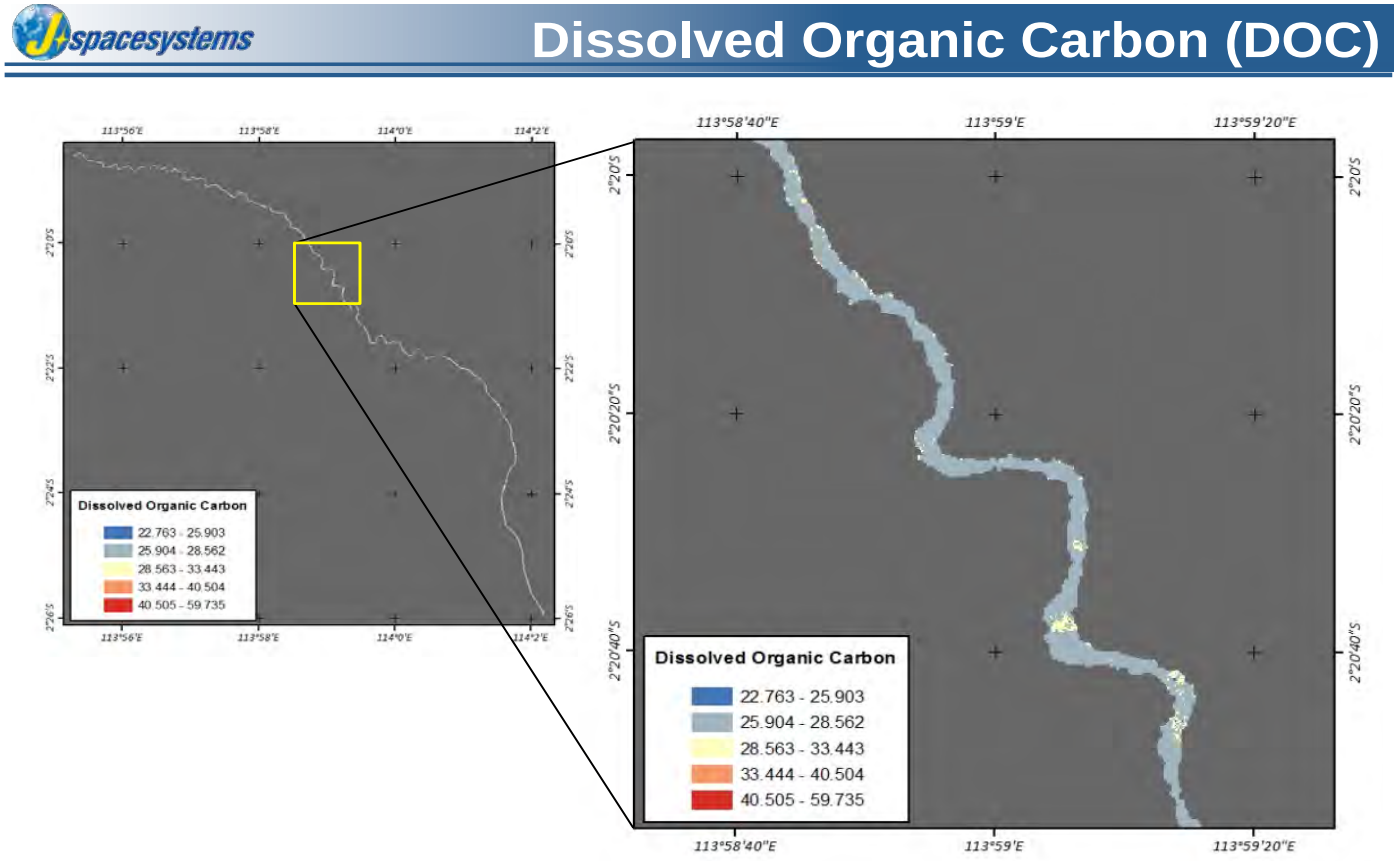
Results

- Relationship between leaf spectra and water potential and/or water contents
  - Higher water content and water potential showed higher water index (wet).
  - Water content and water potential both indicated strong correlation with WBI and NMDI, allowing the modeling using spectral data.
  - The most accurate model for estimating water content and water potential was derived from LASSO regression using reflectance data.





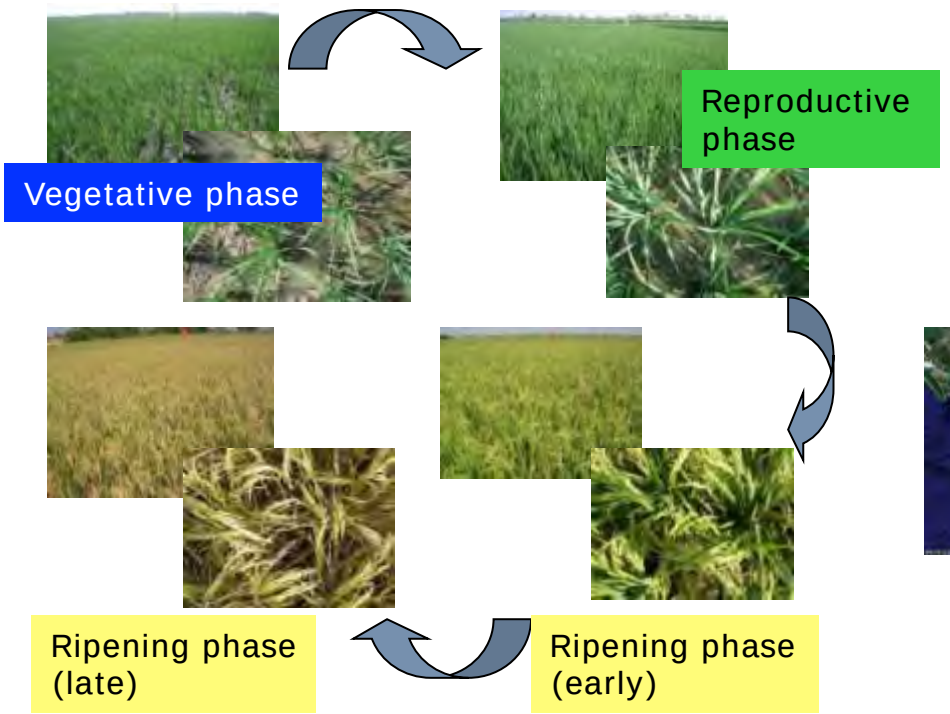
5. Color Dissolved Organic Carbon (CDOC) Mapping

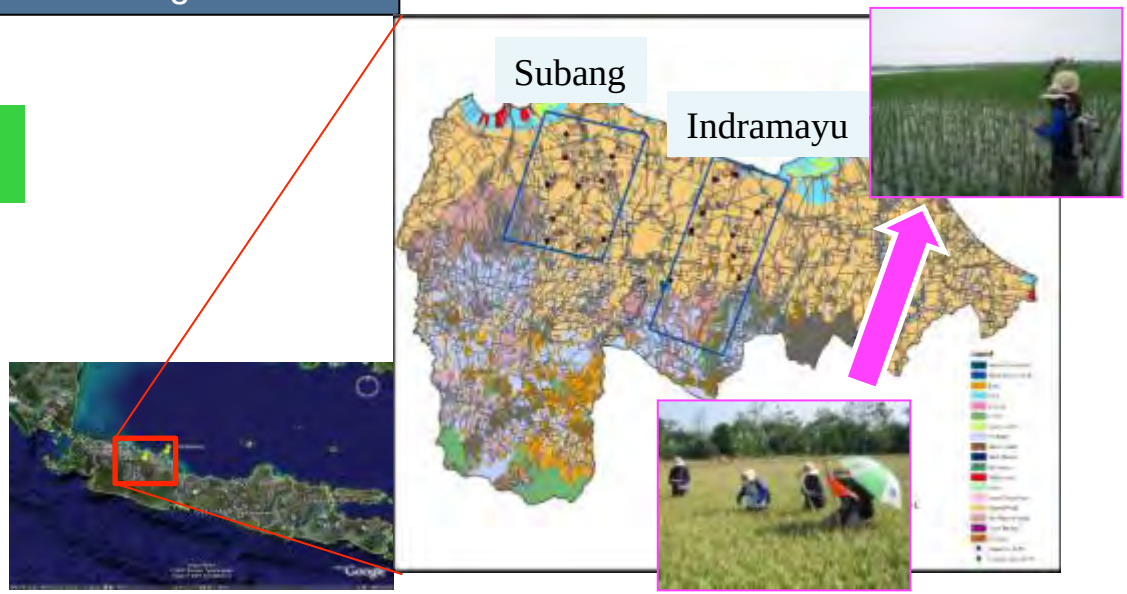


DOC Map in Sebangau Riverm, Central Kalimantan

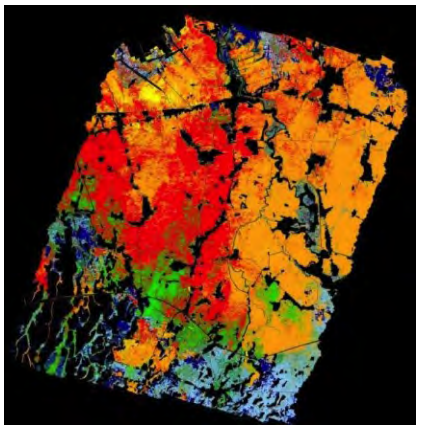
6. Growth Stage Mapping of crops

Various growth stages at the same time within the targeted area

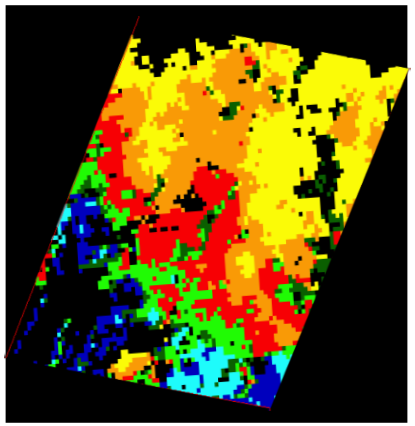




By using hyperspectral data, only one-time acquisition is enough to classify rice growing stage.

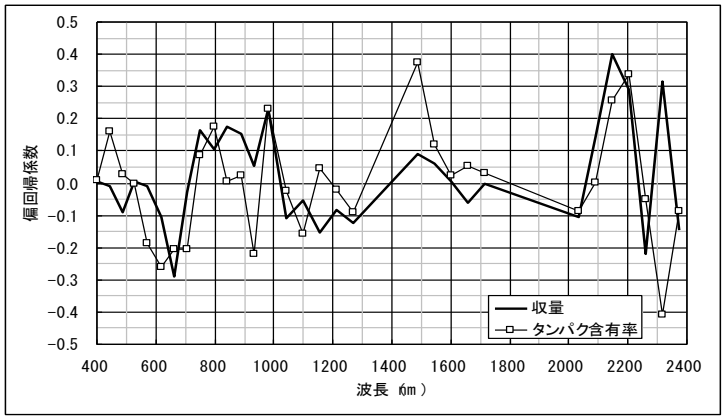


By hyperspectral data of one-time acquisition

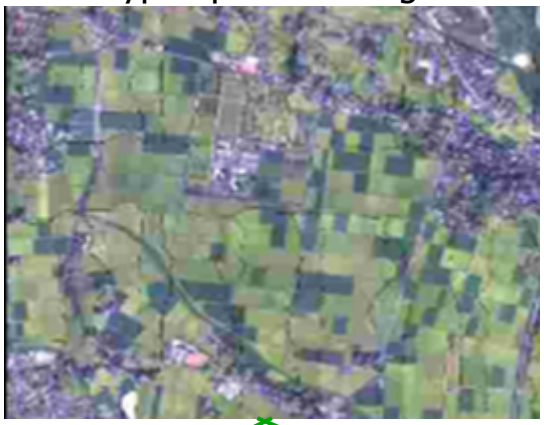


By MODIS data of multi-time acquisitions

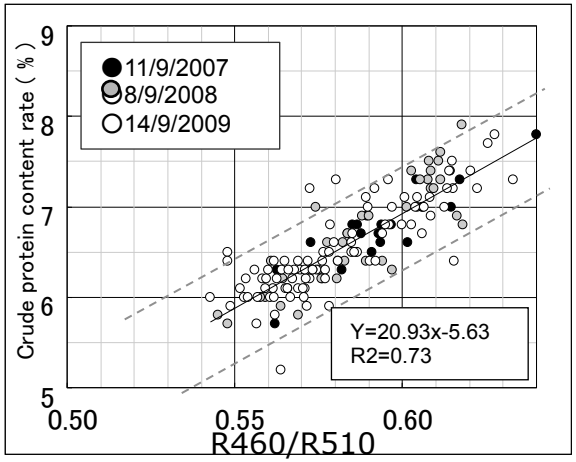
7. Rice yield Mapping



Hyperspectral Image

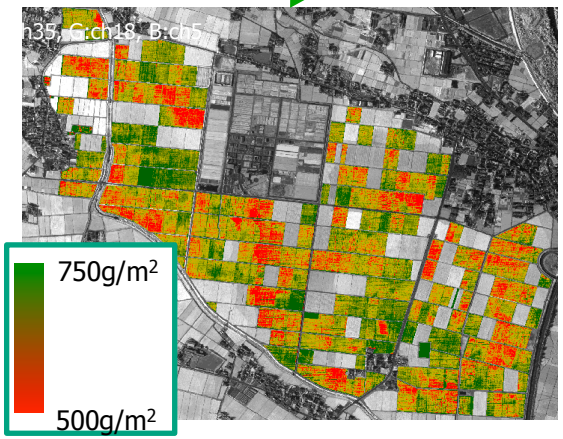


AISA B:661nm G:842nm R:2101nm



$Yield=\Sigma(a_k*R_k)+b$

$CP=20.93*(R460/R510)+5.63$



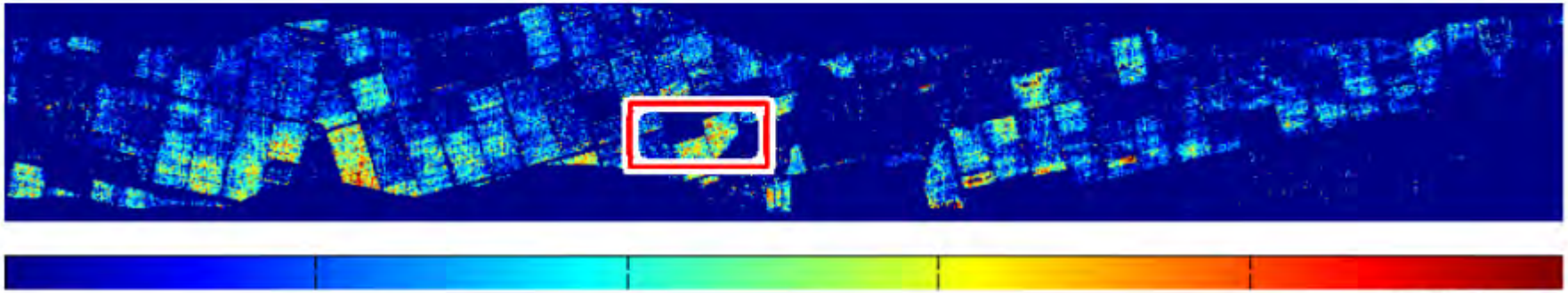
Yield Estimation Map

If hyperspectral data is acquired on the day within 3 weeks before the crop yields, crude protein content rate can be estimated.

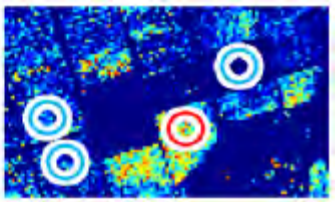
Crude Protein(CP) Estimation Map

8. Disease Mapping: Early detection of Rice blast

Natural color image

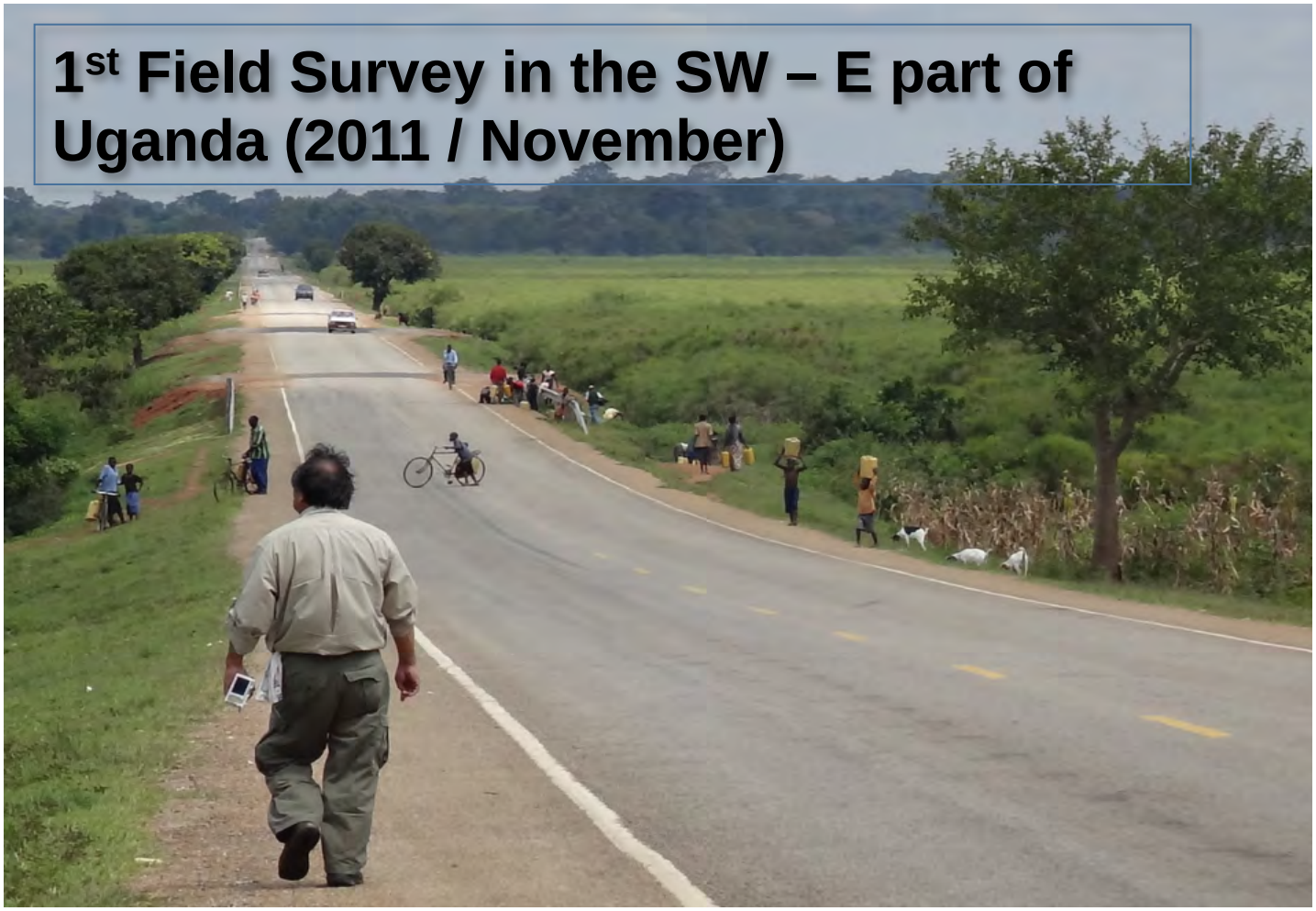


Low Estimated damage map by rice blast Degree of Risk High



Estimate using 3 bands
(595, 700 and 1585nm)

International Collaboration with MRV system



International Collaboration with MRV system