GEOGLAM Asia-RiCE Team Activities Update and Accomplishments

Shin-ichi Sobue

On behalf of the GEOGLAM Asia-RiCE team

2015/11/16

GEOGLAM
Global Agricultural Monitoring

Asia-RiCE
Crop Estimation and Monitoring

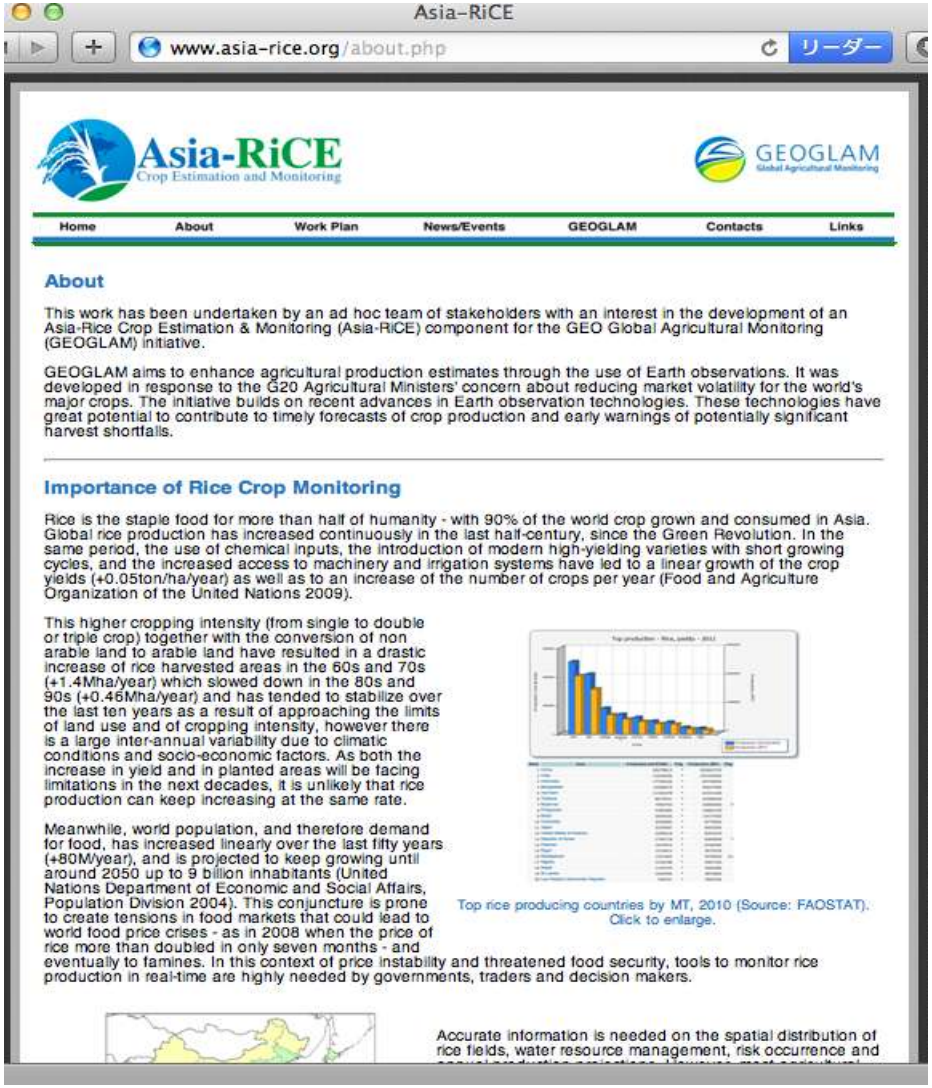
Regional Cooperation for Rice Crop Monitoring Using Space Technology in Asia

Asia-RiCE Crop Estimation and Monitoring

GEOGLAM Global Agricultural Monitoring

http://www.asia-rice.org

Asia-RiCE Home Page – www.asia-rice.org



Asia-RiCE Target Agricultural Products

ID	Target Agricultural Products
P1	**Rice Crop Area Estimates/Maps**
P2	**Crop Calendars/Crop Growth Status**
P3	**Crop Damage Assessment**
P4	**Agro-meteorological Information Products**
P5	**Production Estimation and Forecasting**

Asia-RiCE Team Phasing

CY	Target countries	Task	2013	2014	2015	2016
Phase 1A	Indonesia, Vietnam, Thailand	Area Estimation	APRSAF regional and bilateral cooperation			
		Outlook				
Phase 1B	1A + Japan, Malaysia, Chinese Taipei, Philippines	Area Estimation	Cooperation with AFSIS and Japan			
		Outlook (1A + Philippine)	APRSAF regional and bilateral cooperation			
Phase 2	(TBD) 1A+Japan+???		Cooperation with AFSIS and Japan			
Related activities	ADB TA area (Thai/Viet/Phi /Lao) JFPR	Area Estimation				
	ADB TA agro-met (GMS)	Outlook System Dev				
	GEORIICE	Field survey				

Major Achievements 2015
- Rice Crop Area Estimates/Maps -

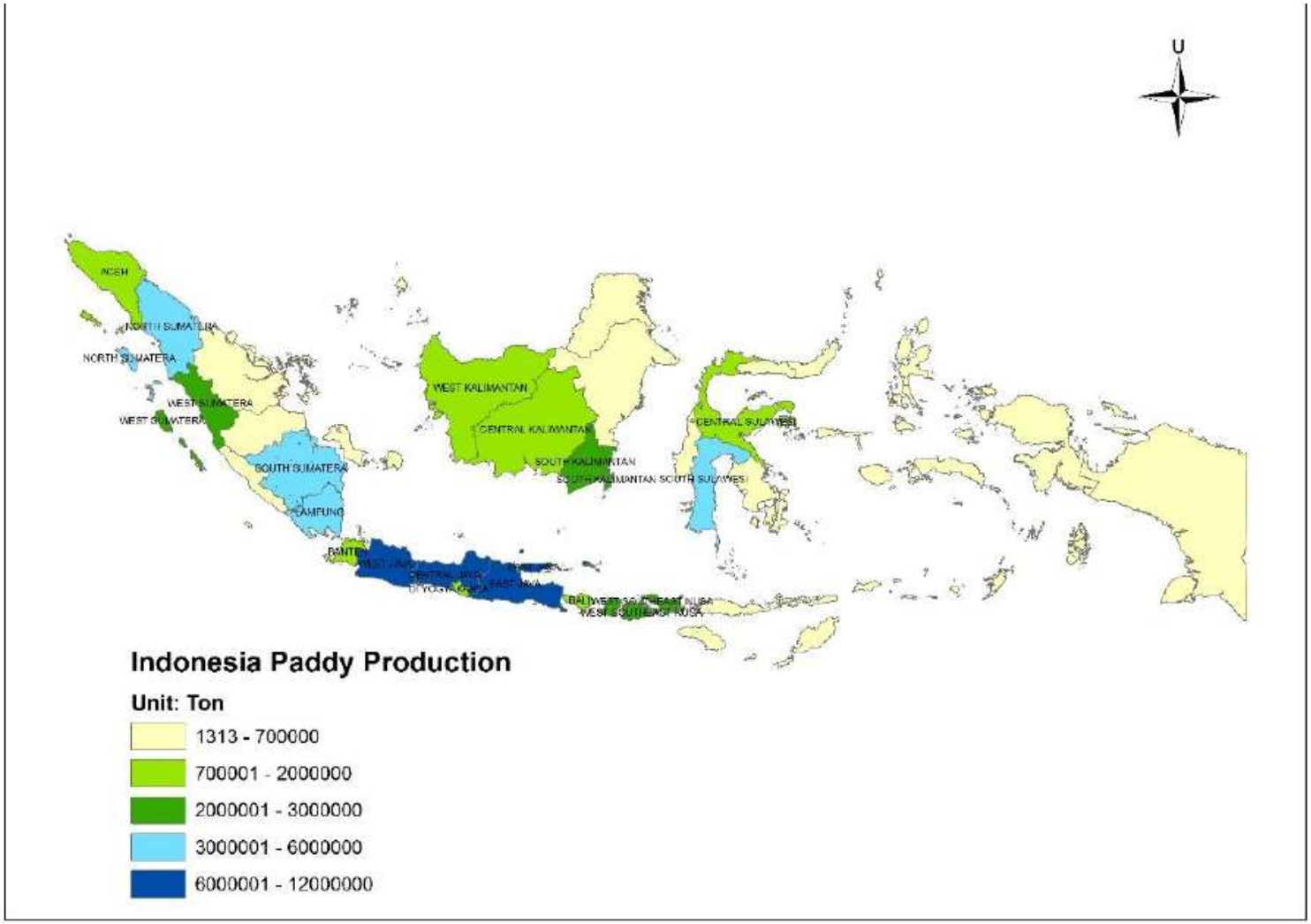
1. Content

- Time series SAR data from multiple providers to estimate rice planted area, growing status, etc. (Indonesia, Vietnam, Thailand, Japan and others)
- JAXA/RESTEC teams developed the INAHOR (rice crop planted area estimation) software
- NASA/CEOS SEO developed & tested a cloud computing SAR processing (INAHOR) platform for Indonesia

2. Target area and period

- Asia-RiCE Phase 1 (from 2014).
  Technical demonstration sites (100x100km) in Asia countries & focus on development of provincial-level rice crop area estimations.
- Phase 2.
  Whole country ("wall-to-wall") rice crop area estimates using wide area mode SAR & other data.

Indonesia rice area for Outlook



Main area: Java, Sumatera, Sulawesi, Kalimantan

Indonesia rice growing calendar for Outlook

Indonesia	Season	Type of Rice		Status	This Year									Next Year					
		Wet Season	Dry Season		Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Marc	Apr	May	Jun
Whole Country	Rainy			Seeding							10	11	12	1	2	3			
				Harvesting	1	2	3							10	11	12	1	2	3
	Dry			Seeding	4	5	6	7	8	9									
				Harvesting				4	5	6	7	8	9						
Java	Rainy			Seeding							10	11	12	1	2	3			
				Harvesting	1	2	3							10	11	12	1	2	3
	Dry			Seeding	4	5	6	7	8	9									
				Harvesting				4	5	6	7	8	9						
Sumatera	Rainy			Seeding							10	11	12	1	2	3			
				Harvesting	1	2	3							10	11	12	1	2	3
	Dry			Seeding	4	5	6	7	8	9									
				Harvesting				4	5	6	7	8	9						
Sulawesi	Rainy			Seeding							10	11	12	1	2	3			
				Harvesting	1	2	3							10	11	12	1	2	3
	Dry			Seeding	4	5	6	7	8	9									
				Harvesting				4	5	6	7	8	9						

Definition :

Dry Season Rice refers to rice planted during April to September to April of this year

Wet Season Rice refers to the rice planted during October of this year to March of next year

Note: color show the desnity of planting and harvesting

Peak Seeding

Seeding

Peak Harvesting

Harvesting

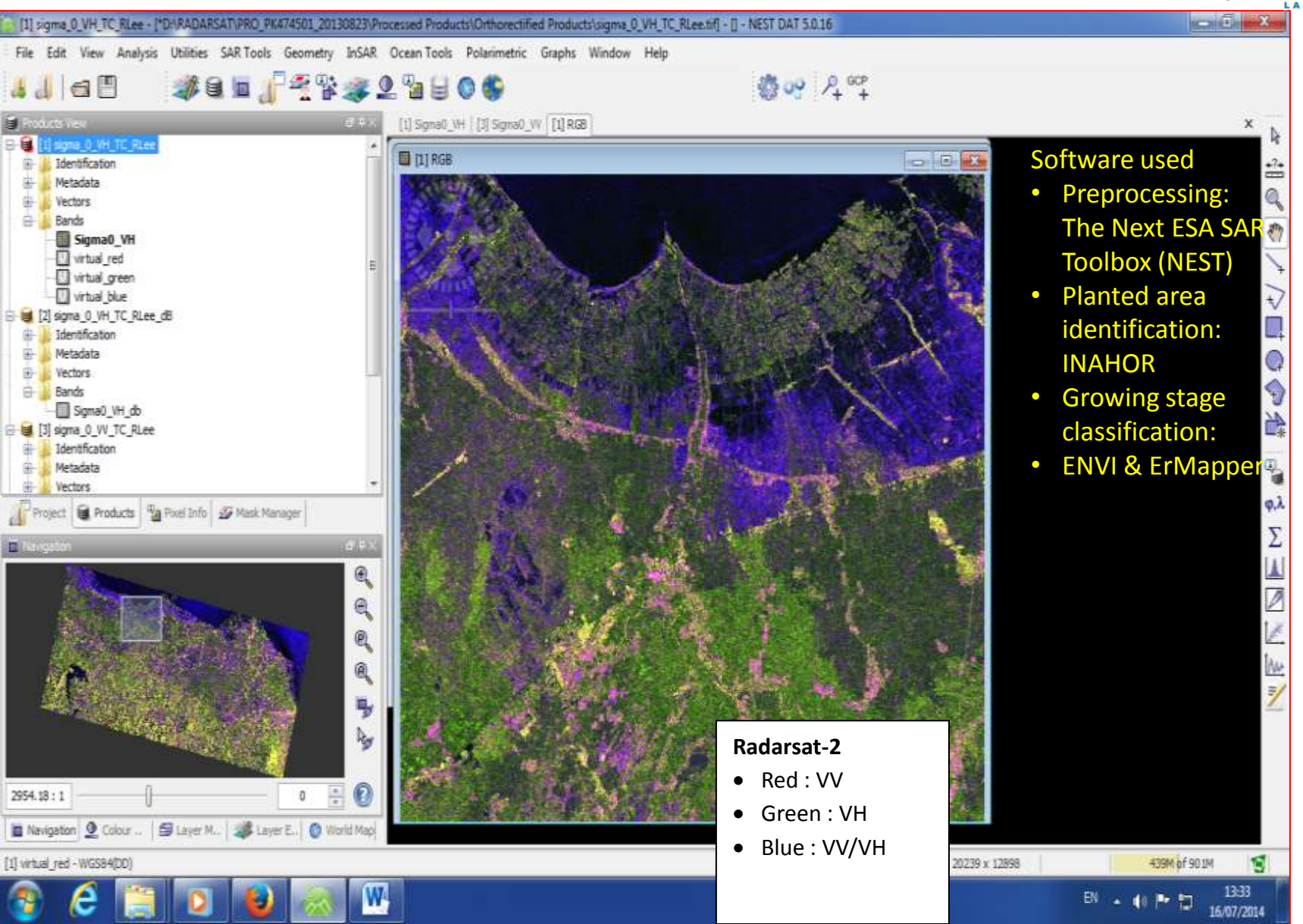
Source: Statistic Indonesia 2012-2013, Discussion with AFSIS expert.

- The habits of most Indonesian farmers are planting when water is availabel so there is no firm timetable at planting and harvest time.

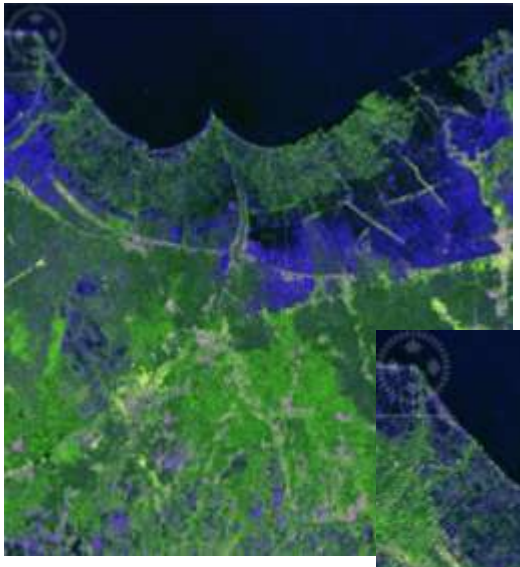
Rainy (wet) crop : Rice1,

Dry crop: Rice 2

RADARSAT-2 DATA ANALYSIS

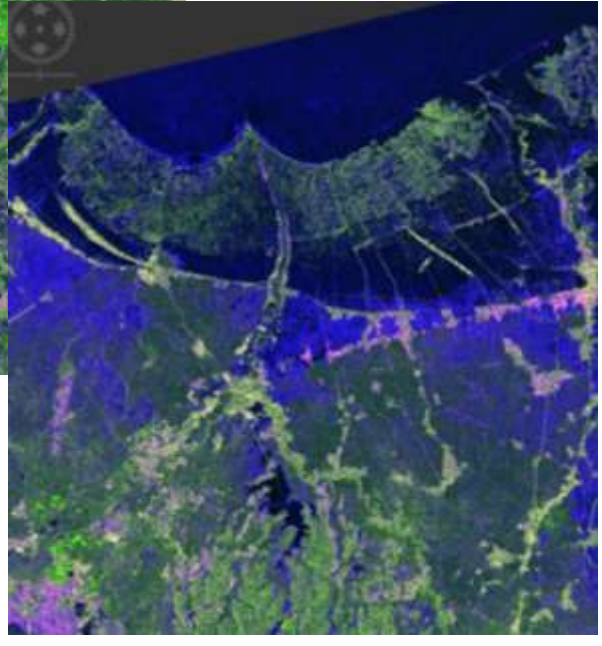


Example Achievements – Indonesia
RADARSAT-2 Rice Phenological Stage Classification (RGB composite)



23 August

3 November



11 February

Frequent acquisitions allow backscatter ratio (and hence growth stage) to be tracked over time.

Subang Area, West Java. Analysis by Indonesian MOA and LAPAN with JAXA.

Red : VV

Green : VH

Blue : VV/VH

SAR Images of Phenological Stages

- Each Sample Area was classified into 6 phenological stages based on the visual interpretation of photos

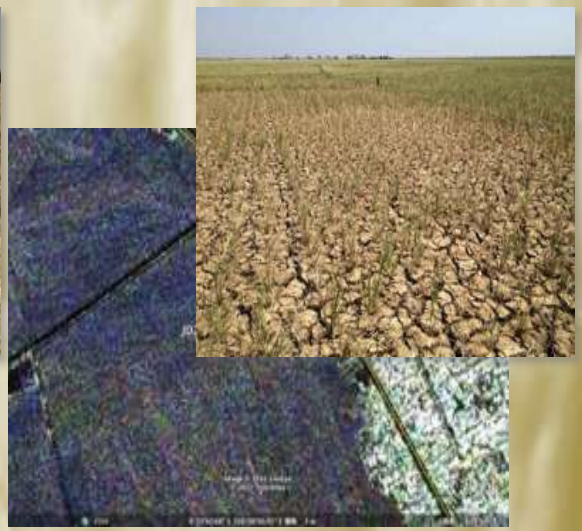
Planting

Vegetated1

Vegetated2

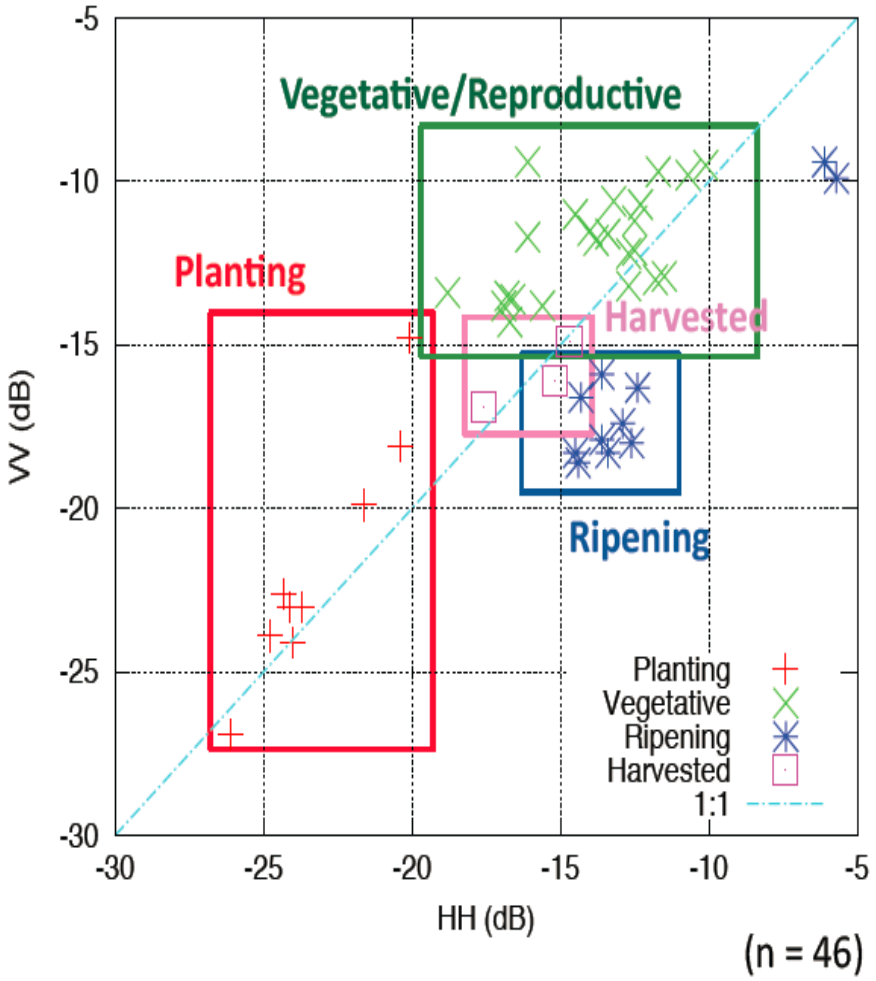
Harvesting

Harvested



Drought

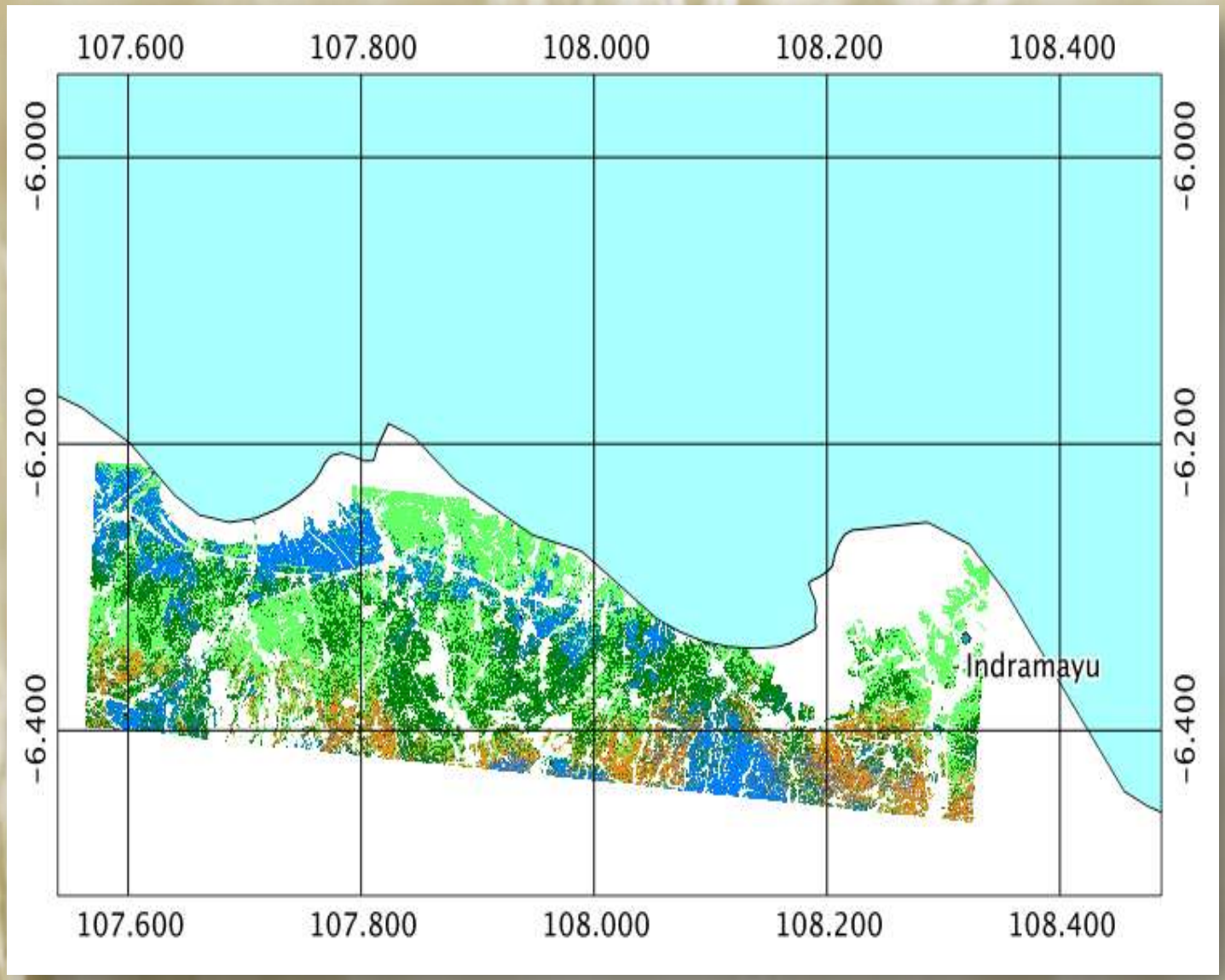
Relationships between Rice Phenology and HH/VV



- **Planting**
  - Low HH and VV
- **Vegetative/Reproductive**
  - High HH and VV
  - VV > HH
- **Ripening**
  - HH > VV
- **Harvested**
  - HH ≒ VV

Each phenological stage (Growth Profiles) has its HH/VV signature.

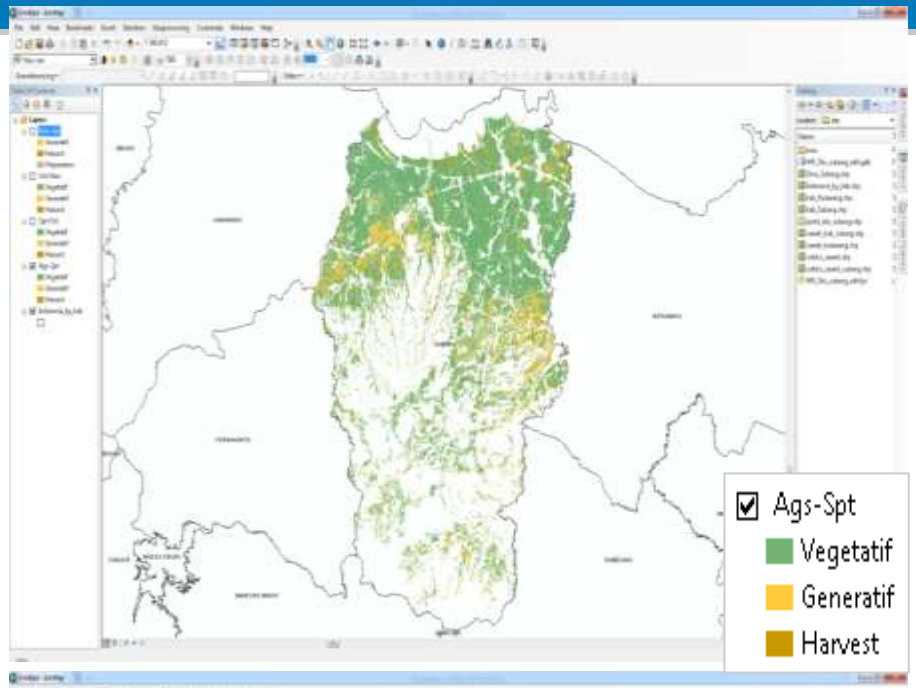
Mapping Result with Paddy Field Mask

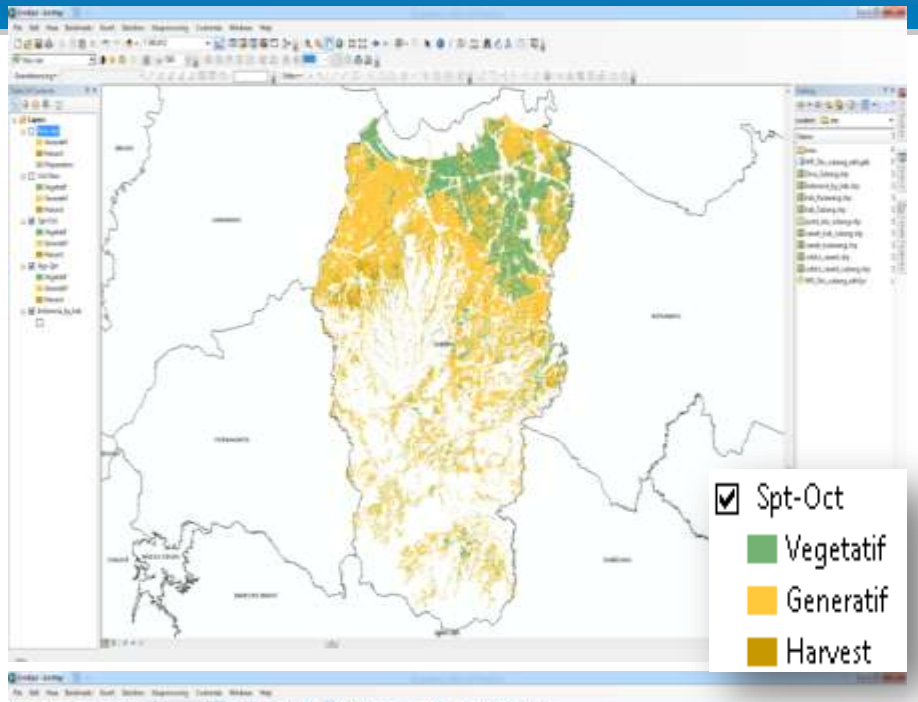


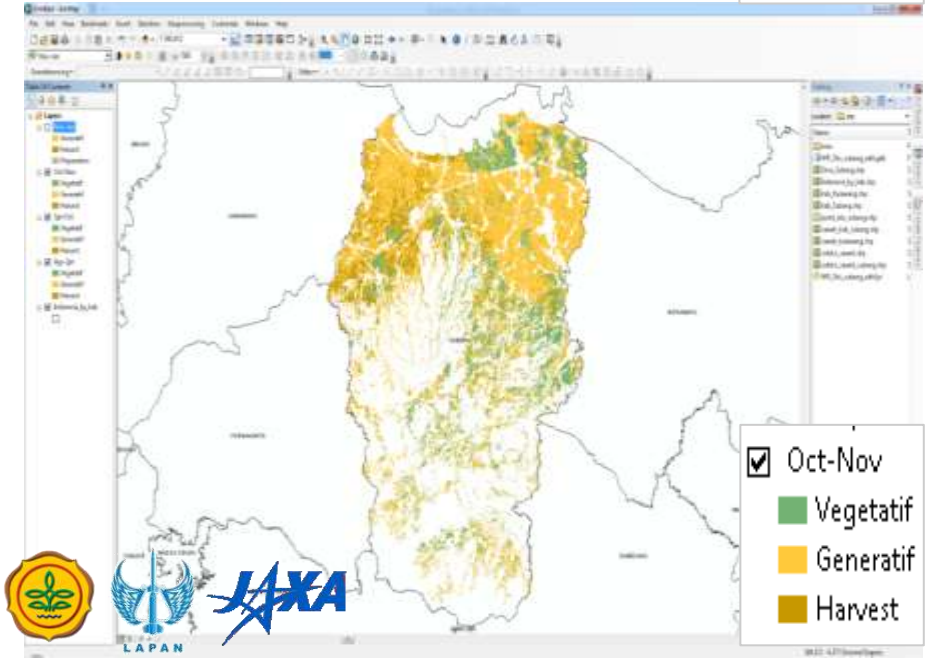
- Planting
- Vegetated 1
- Vegetated 2
- Harvesting

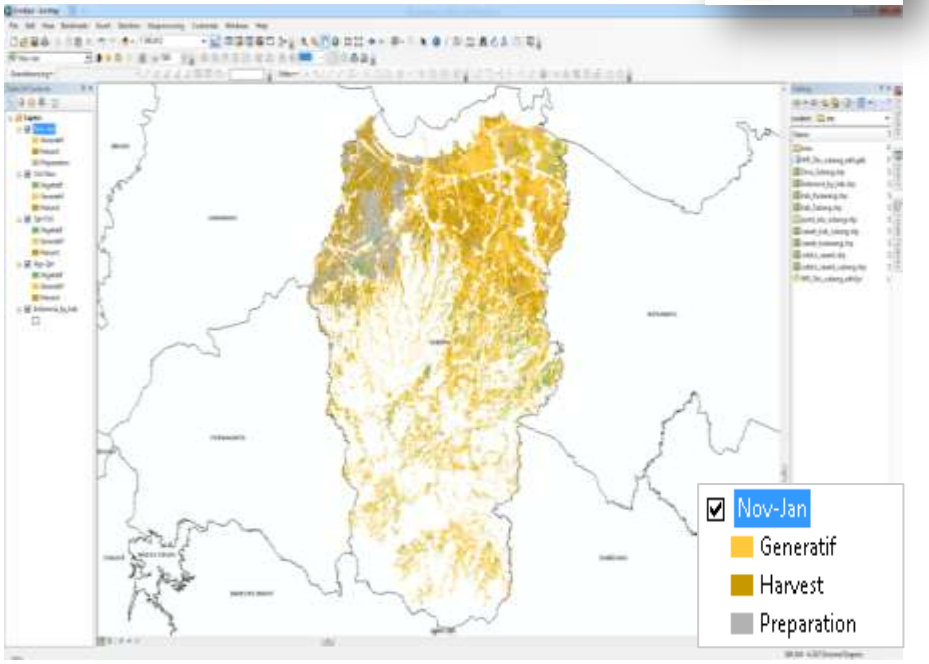
Rice Phenological Stages Classification using ALOS PALSAR 2 Data (VH_VV)

August 2014 - Jan 2015 (Subang Area, West Java)



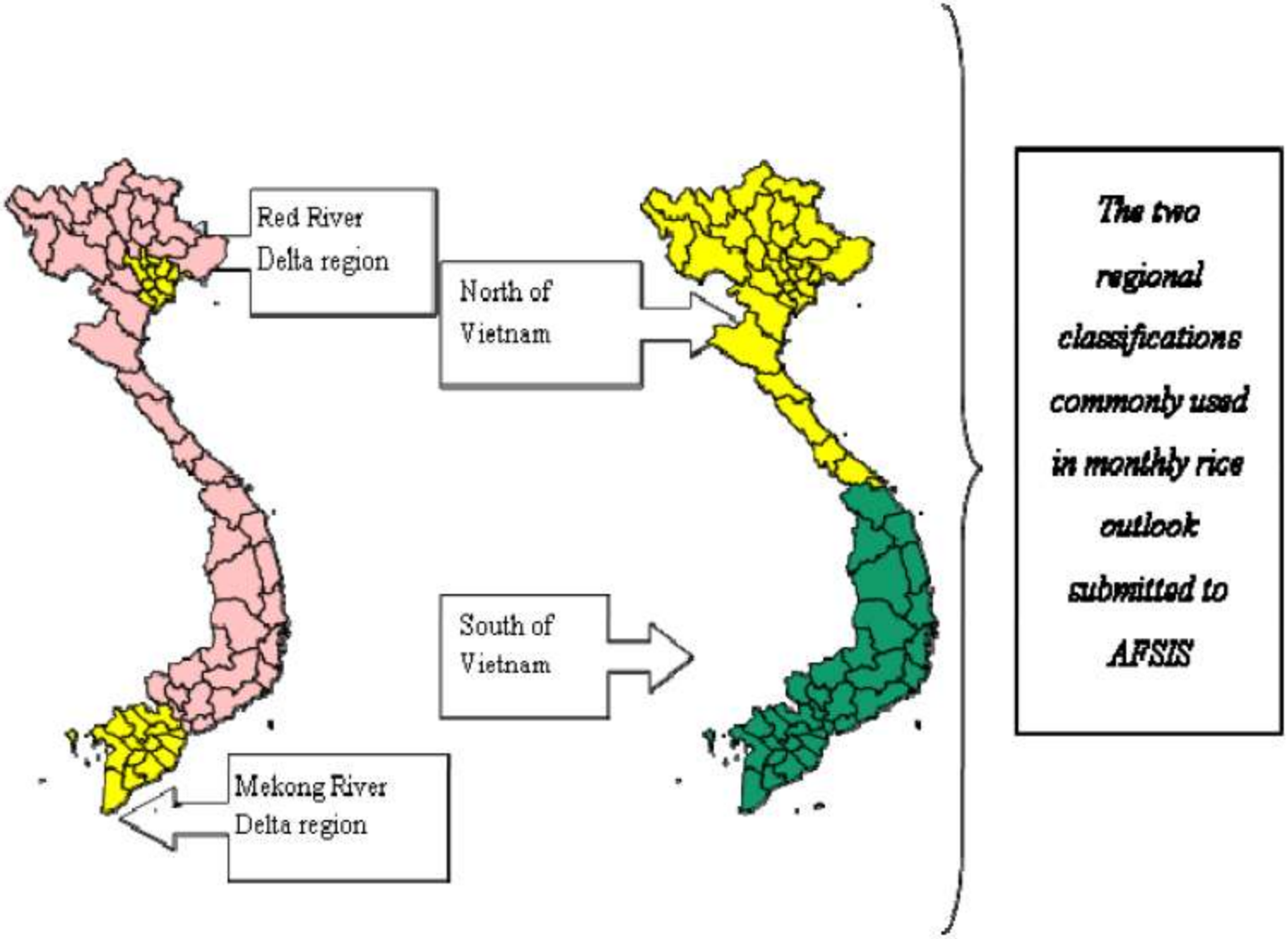






LAPAN JAXA

Vietnam rice crop area



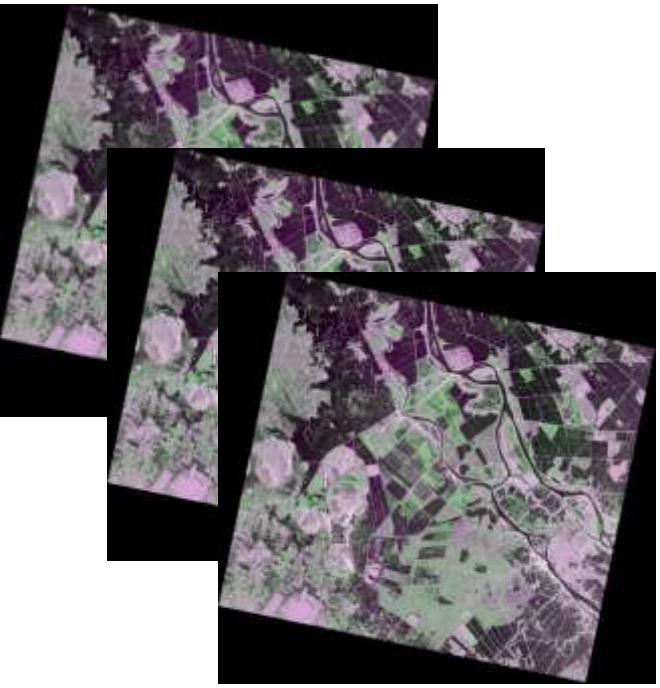
Vietnam rice growing calendar for Outlook

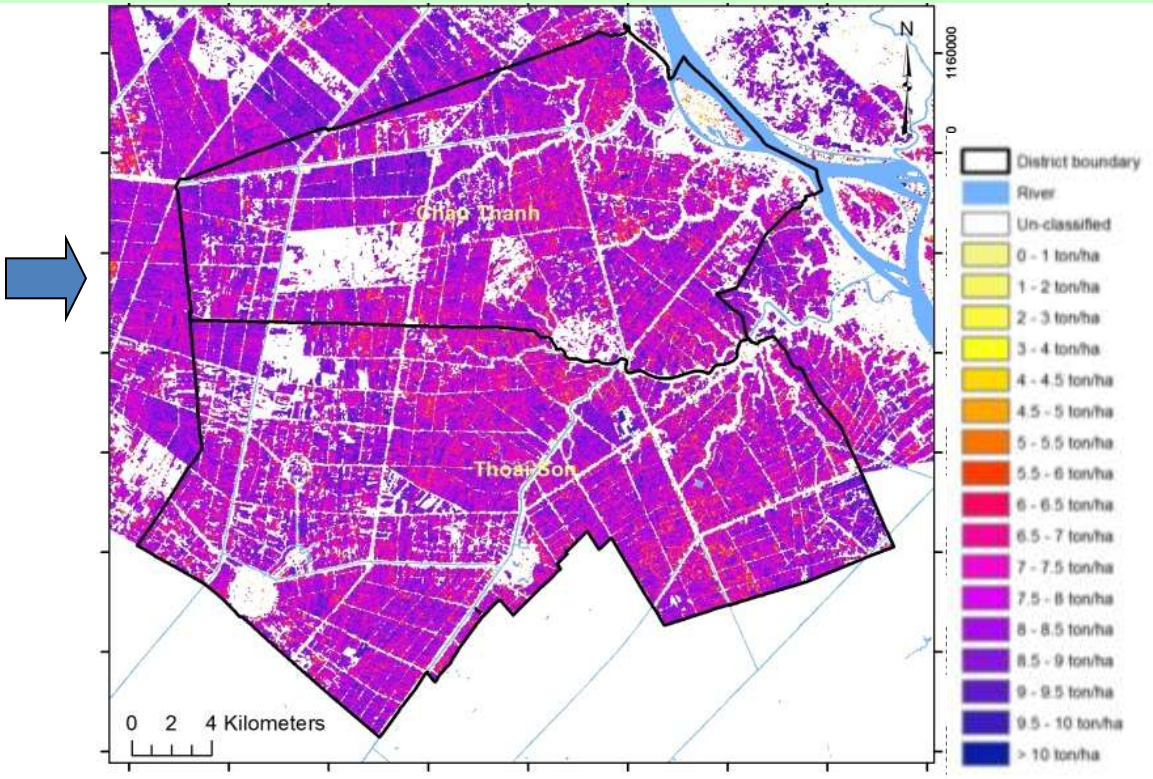
Vietnam	Season	Type of rice		Status	Months											
		Wet season	Dry season		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North	Winter-Spring		●	Seeding	■	■								■	■	■
				Harvesting												
	Summer-Aumtumn	●		Seeding					■	■	■	■	■	■	■	
				Harvesting												
	Summer	●		Seeding					■	■	■	■	■			
				Harvesting												
South	Winter-Spring	●	●	Seeding	■								■	■	■	■
				Harvesting												
	Summer-Aumtumn	●		Seeding			■	■	■	■	■					
				Harvesting												
	Summer	●		Seeding						■	■	■	■			
				Harvesting												
	Autumn-Winter	●		Seeding								■	■			
				Harvesting												
			Note:	Seeding	■											
				Harvesting												

- Above table is the result of the Discussion between CIS and an expert of the Cultivation Department in September 2013.

Summer and Autumn-Winter (WET) : Rice1,
Summer-Autumn (WET): Rice 2,
Winter-Spring (DRY): Rice 3

Rice area and yield estimation using R2 in Ann Gang
by Lam Dao Nguyen, Thuy Toan et al





$Y_{Ra} = 11.73063 + 13.5107*Ra_1 - 85.4393*Ra_2 - 78.03883*Ra_3$

$r^2 = 0.779$, $se_y = 0.3$ ton/ha

Where:

Y_{Ra} : rice yield (ton/ha),
Ra_1 : ⋅ º of VH polarisation of first date image,
Ra_2 : ⋅ º of VH polarisation of second date image,
Ra_3 : ⋅ º of VH polarisation of third date image,
r^2 : the coefficient of determination,
se_y : the standard error for the y estimate.

A distribution map of estimated rice yield in WS 2014 crop at Chau Thanh and Thoai Son district using three-date VH polarisation:

- RADARSAT-2 27 Dec 2013
- RADARSAT-2 20 Jan 2014
- RADARSAT-2 13 Feb 2014

CESBIO

V.A.S.T

Rice area and yield estimation using R2 in Ann Gang
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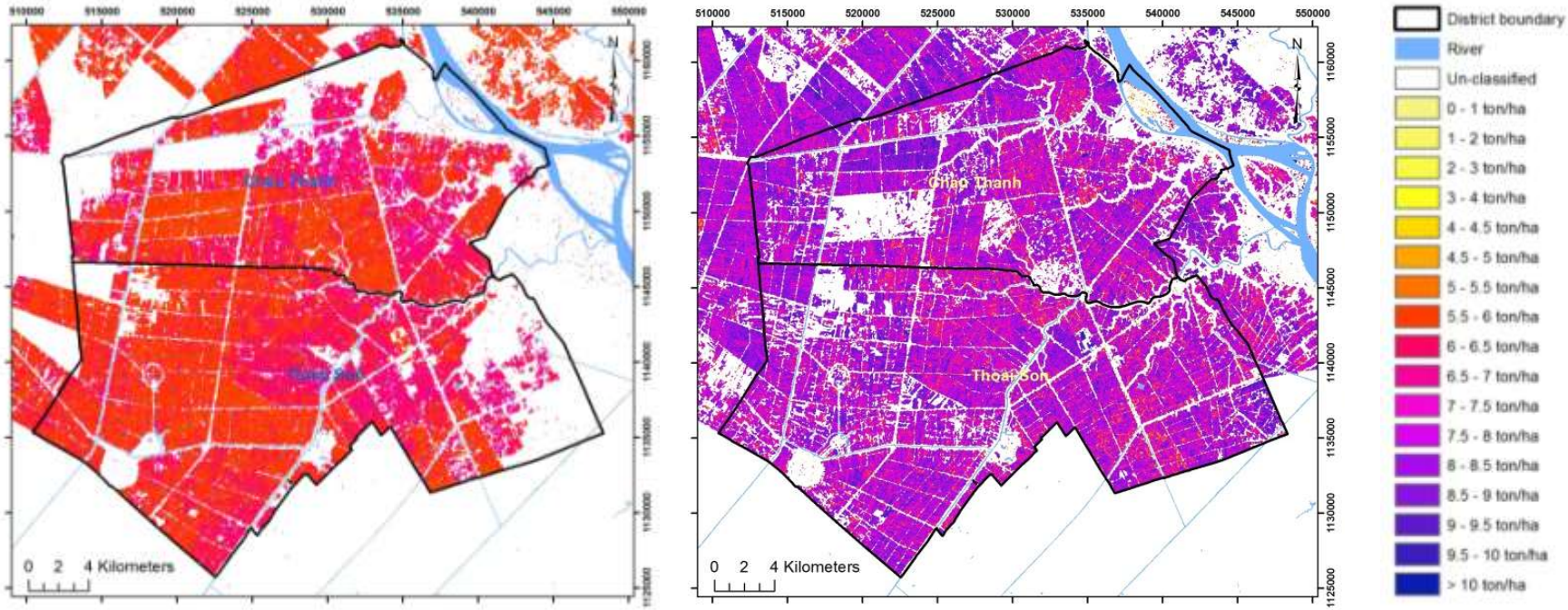

A distribution map of estimated rice yield in AW 2013 crop at Chau Thanh and Thoai Son district using three-date VH polarisation:

- RADARSAT-2 29 Aug 2013
- RADARSAT-2 16 Oct 2013
- RADARSAT-2 09 Nov 2013

A distribution map of estimated rice yield in WS 2014 crop at Chau Thanh and Thoai Son district using three-date VH polarisation:

- RADARSAT-2 27 Dec 2013
- RADARSAT-2 20 Jan 2014
- RADARSAT-2 13 Feb 2014

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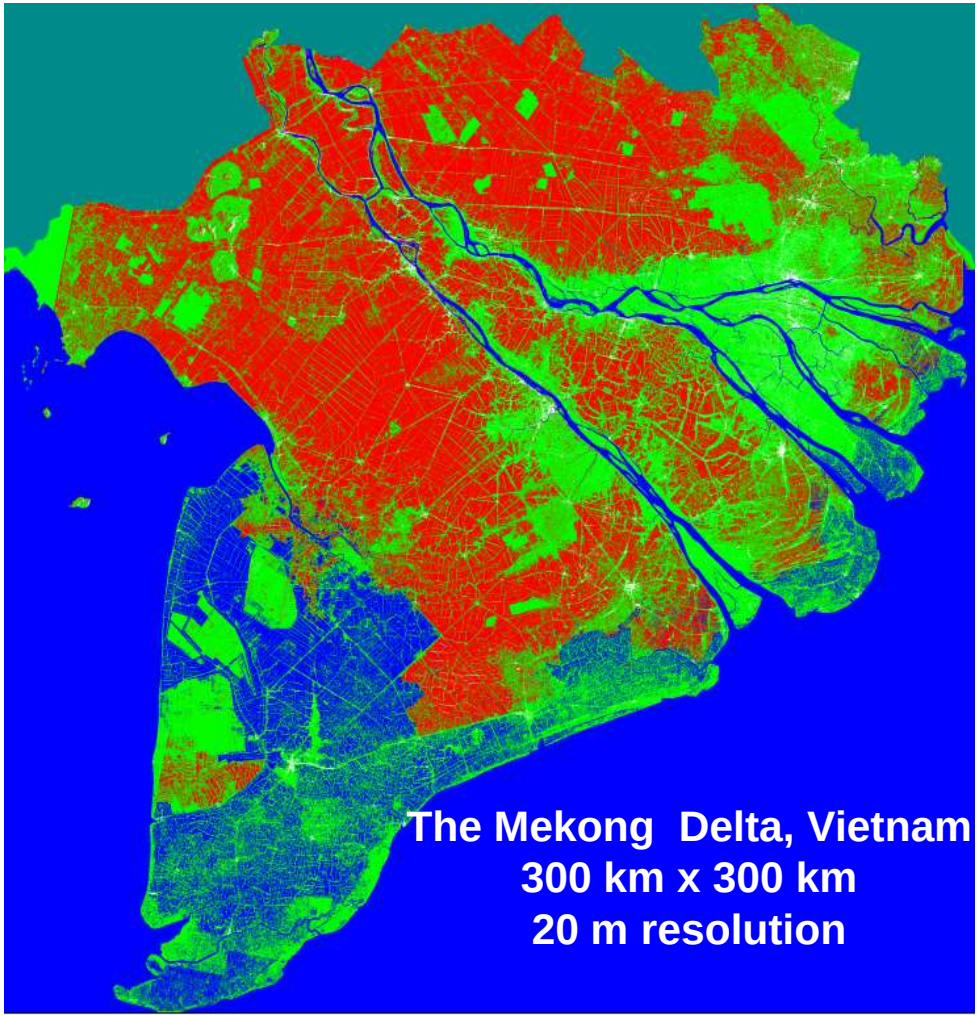
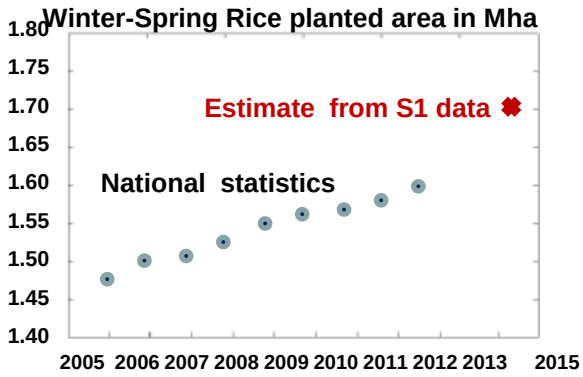
Rice monitoring using Sentinel-1A data

Estimate and map of Winter-Spring Rice (January-April) 2015





Estimated Winter-Spring planted area in 2015: 1.704 Mha

Rice (Winter-Spring)
Non rice (forest, other LULC)
Water (ocean, river, aquaculture)
Land outside the Vietnam Mekong delta

IW S1 Data: 10 January, 03 February, 27 February, 11 March, 23 March, 04 April, 16 April 2015

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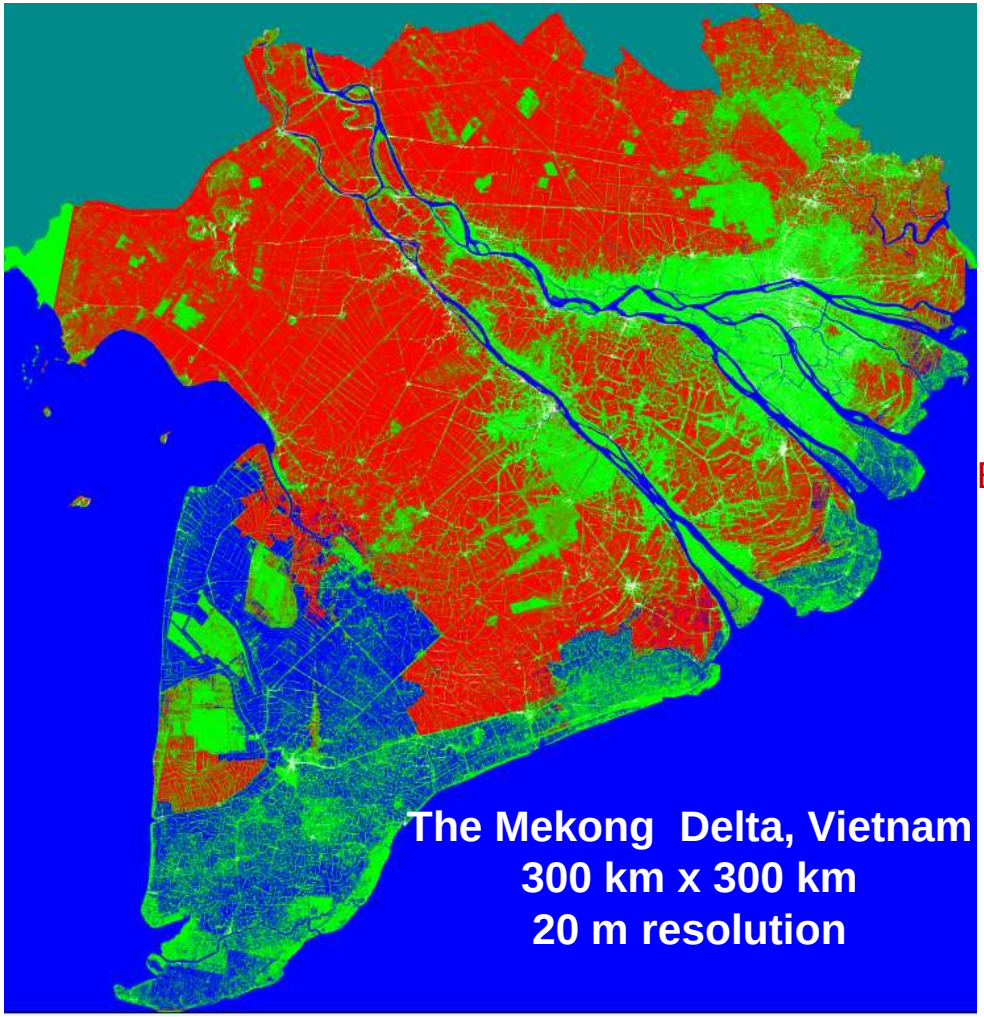
Asia-RiCE
Crop Estimation and Monitoring

innovators
georice

Rice monitoring using Sentinel-1A data

Estimate and map of Spring-Summer Rice (April-July) 2015



Mapping result obtained by 21 July 2015

IW S1 Data: 28 April, 10 May, 16 May, 15 June, 9 July, 21 July 2015

Estimated Spring-Summer planted area in 2015: 2.14 Mha

Rice (Winter-Spring)
Non rice (forest, other LULC)
Water (ocean, river, aquaculture)
Land outside the Vietnam Mekong delta

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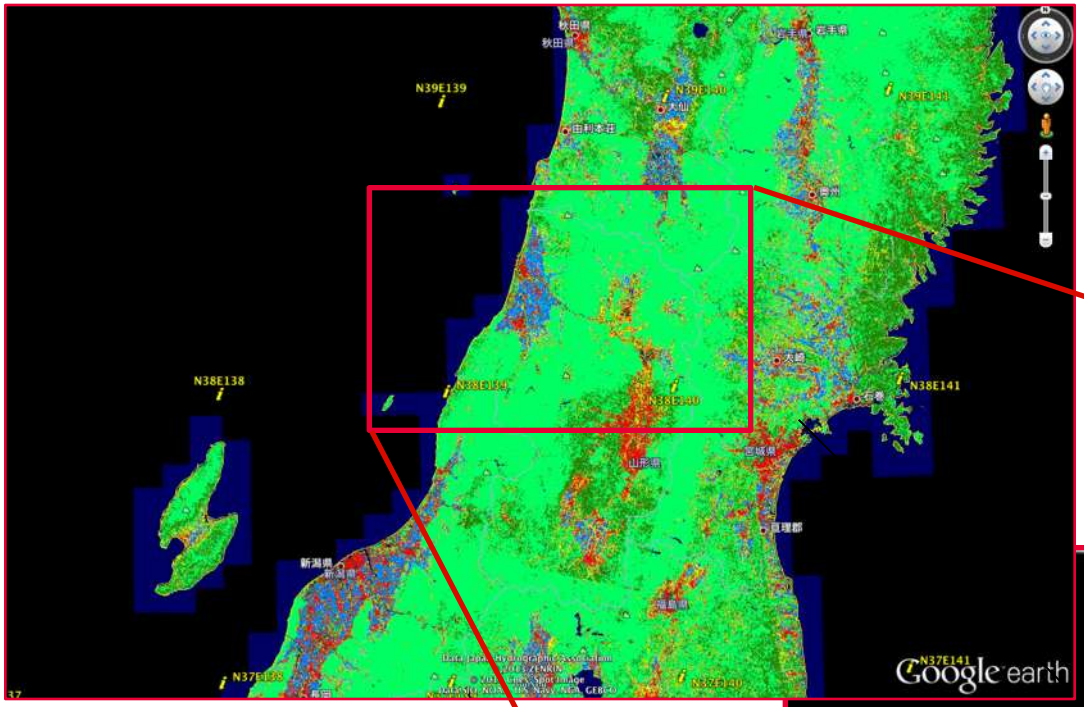
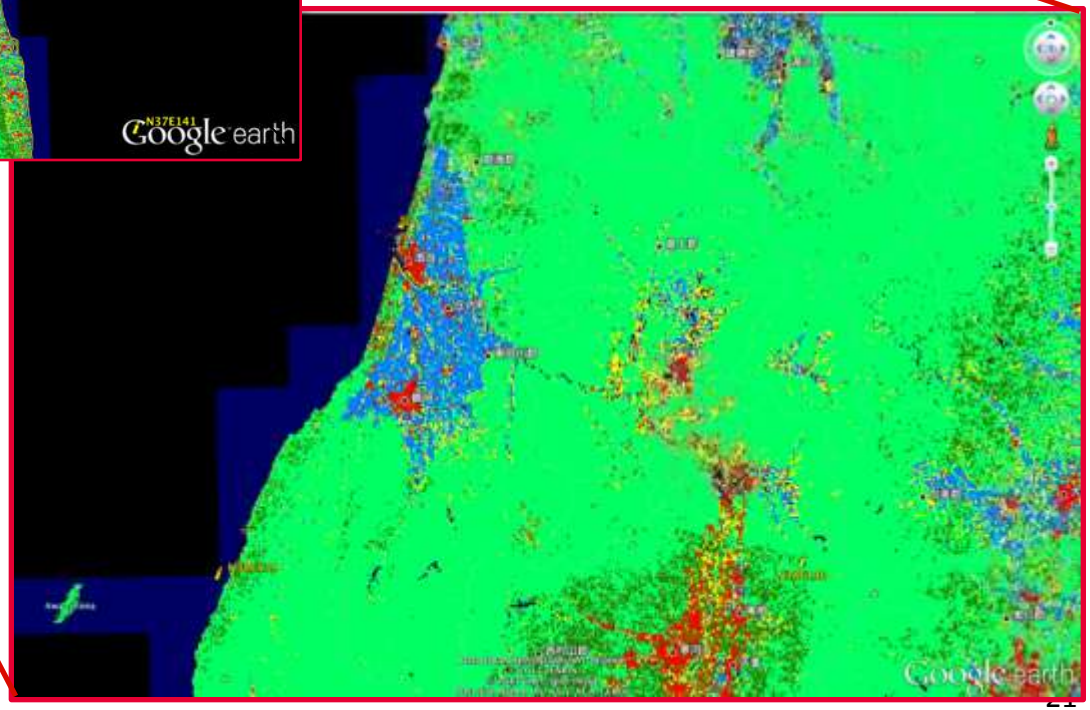
Land Cover Map over Japan by ALOS





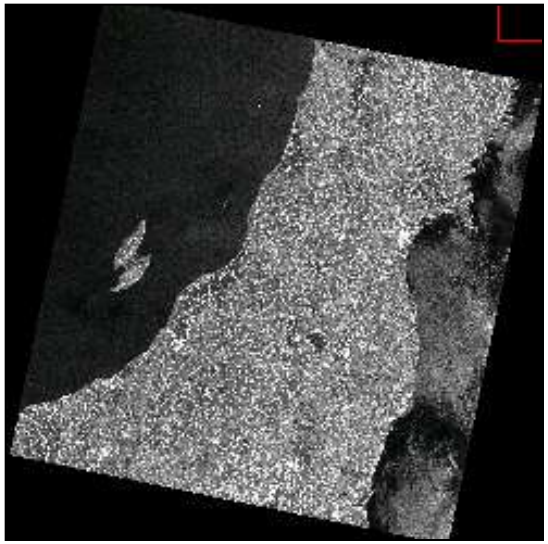
カテゴリー Category

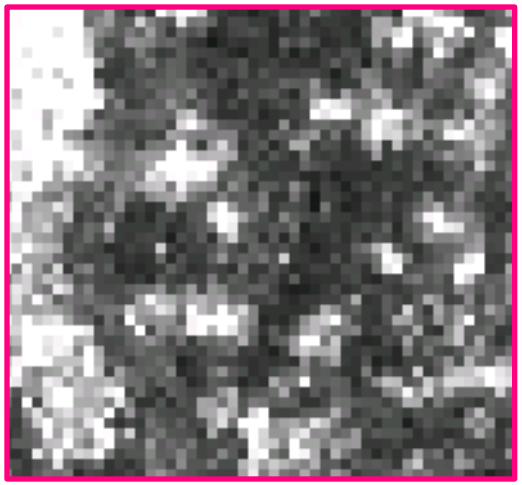
1	水域 Water
2	都市 Urban
3	水田 Paddy
4	畑地 Crop
5	草地 Grass
6	落葉樹 Deciduous forest
8	常緑樹 Evergreen forest
10	裸地, 砂地 Bare surface
11	雪氷 Snow and ice
	その他 other

Tsuruoka City, Yamagata, Japan

ALOS PALSAR ScanSAR
(2010/06/28)

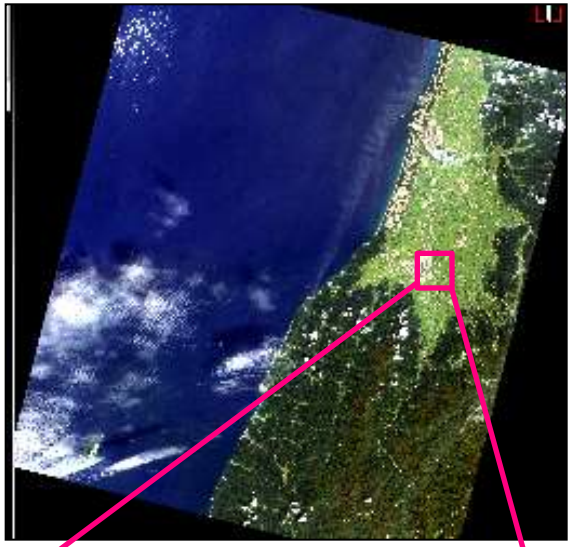
100m@350km





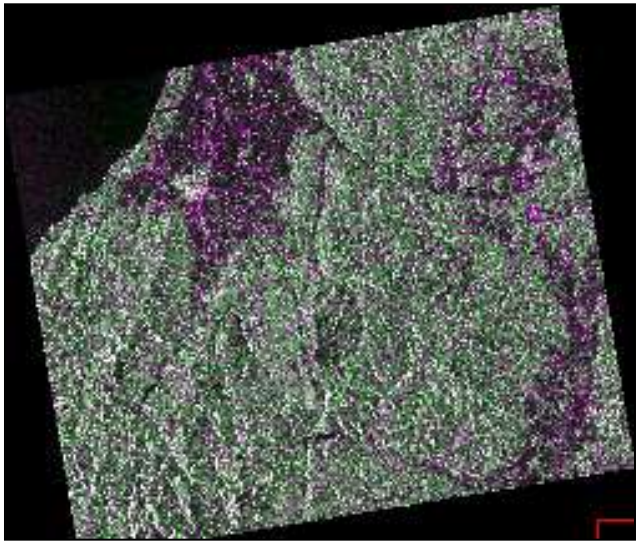
ALOS AVNIR-2
(2010/08/28)

10m@70km



ALOS PALSAR Fine
(2009/07/30)

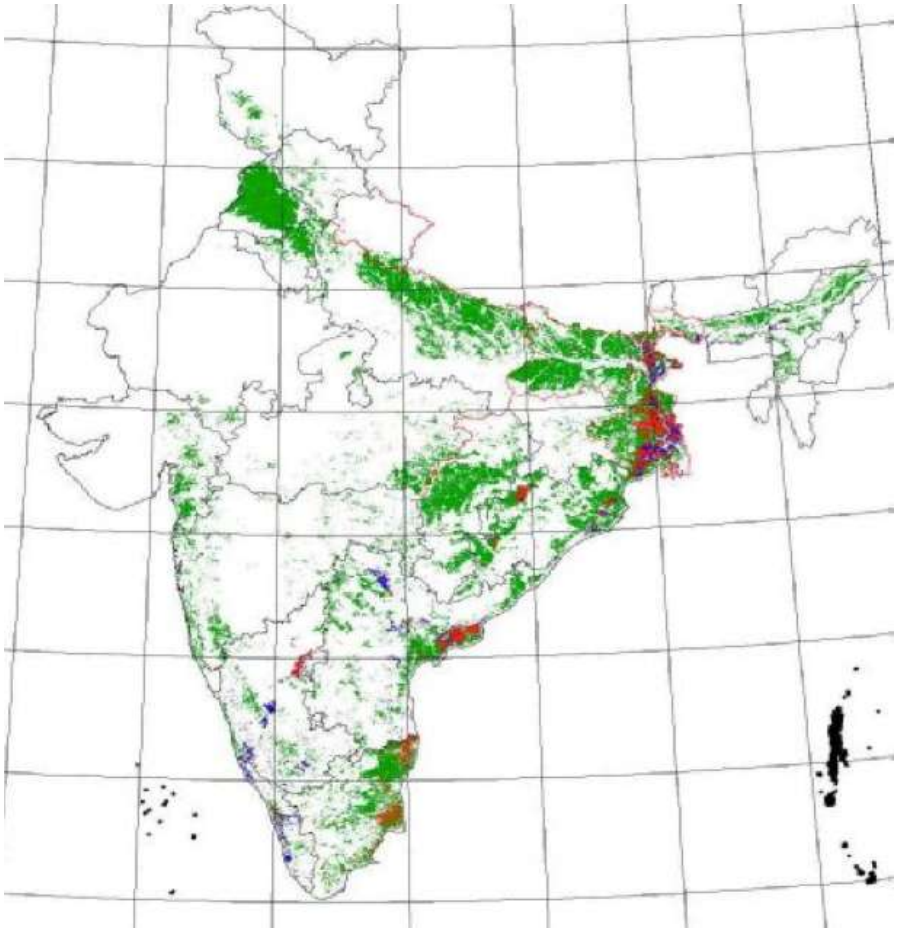
15m@70km



AWS in Tsuruoka, Yamagata, Japan

http://www.x-ability.jp/FieldRouter/vbox0098/

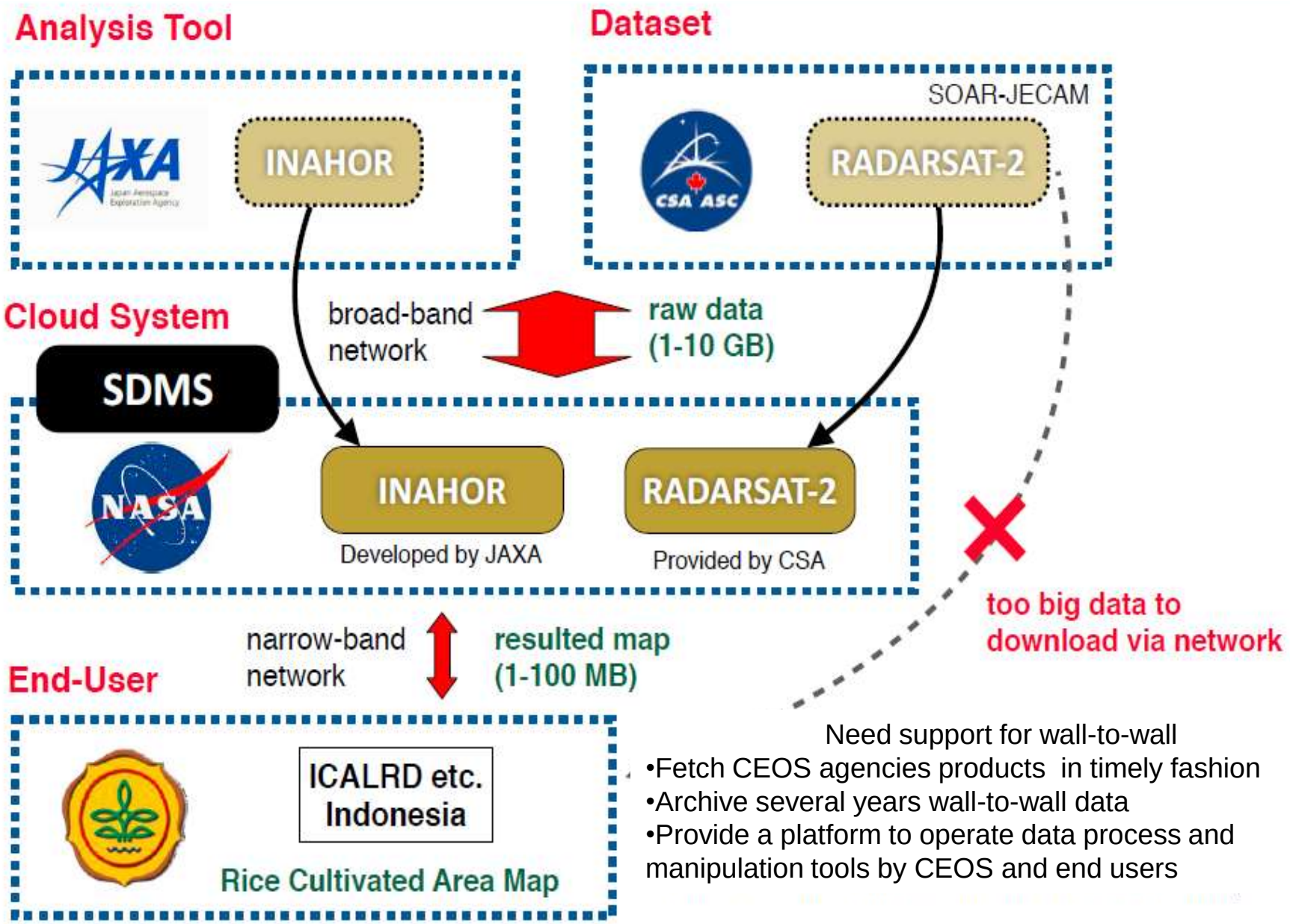
Asia-RiCE Team Member Highlights
Example Achievements – India



Rice map of India derived using satellite data. Multi-date SPOT VGT 10-day composite Normalised Difference Vegetation Index data is used along with RADARSAT SAR and IRS WiFS data to map the rice area and generate the seasonal rice cropping pattern and crop calendar. Source: Spatial Database Generation Of The Rice-Cropping Pattern Of India Using Satellite Remote Sensing Data (Manjunath & Panigrahy, 2009)

The green color is we season rice (main season/rainy season), the red color is rice in both seasons, the blue color is rice in second season.

INAHOR on Cloud Computing System (SDMS)



Need support for wall-to-wall

- Fetch CEOS agencies products in timely fashion
- Archive several years wall-to-wall data
- Provide a platform to operate data process and manipulation tools by CEOS and end users

ADB regional capacity development technical assistance 8369: Innovative Data Collection Methods for Agricultural and Rural Statistics

This project aims to enhance the capabilities of **IN**ternational **A**sian **H**arvest m**O**nitoring system for **R**ice (INAHOR), a software application developed by the Japan Aerospace Exploration Agency (JAXA) for estimating rice crop area and production using radar satellite imagery on Lao PDR, Philippines, Thailand and Viet Nam

Impact:

More evidence-based policies and programs on food security

Outcome:

Improved quality and timeliness of rice crop area and production estimates and forecasts.

Outputs:

1. Customized software applications on analyzing satellite imagery and similar tools provided to pilot countries.
2. Selected staff in pilot countries are able to use output 1 as inputs into rice crop estimation and forecasting methods.
3. Online training program on the use of satellite imagery and similar tools for agricultural and rural statistics provided for open access.

What is INAHOR-AD?

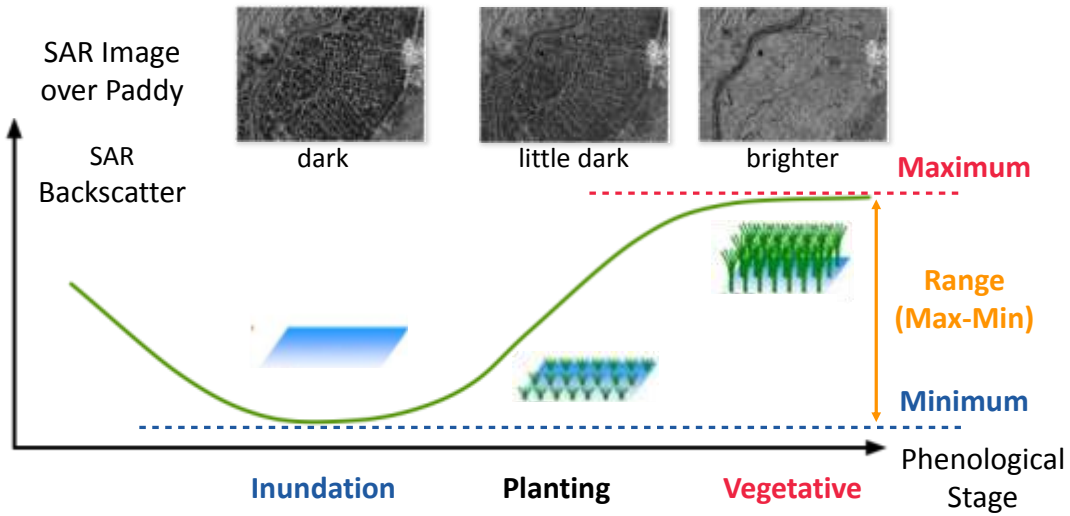
"INternational Asian Harvest mOnitoring system for Rice"
– Advanced version

What can you expect ?

- Mapping of rice planted area
- Calculation of rice planted area
- Calculation of rice production (need yield data)

Basic Concept of Rice Planted Area Detection

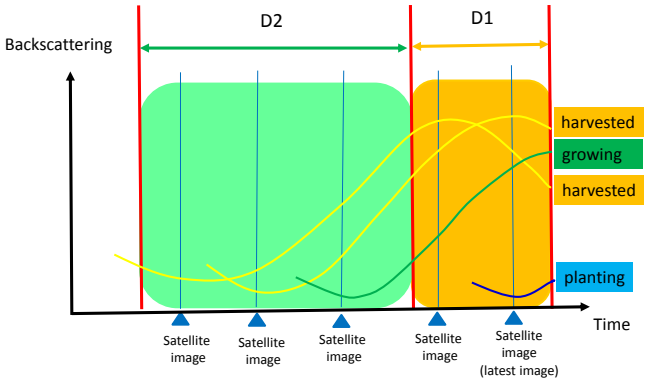
- Paddy rice area has **"Inundation"** and **"Vegetative"** stages.



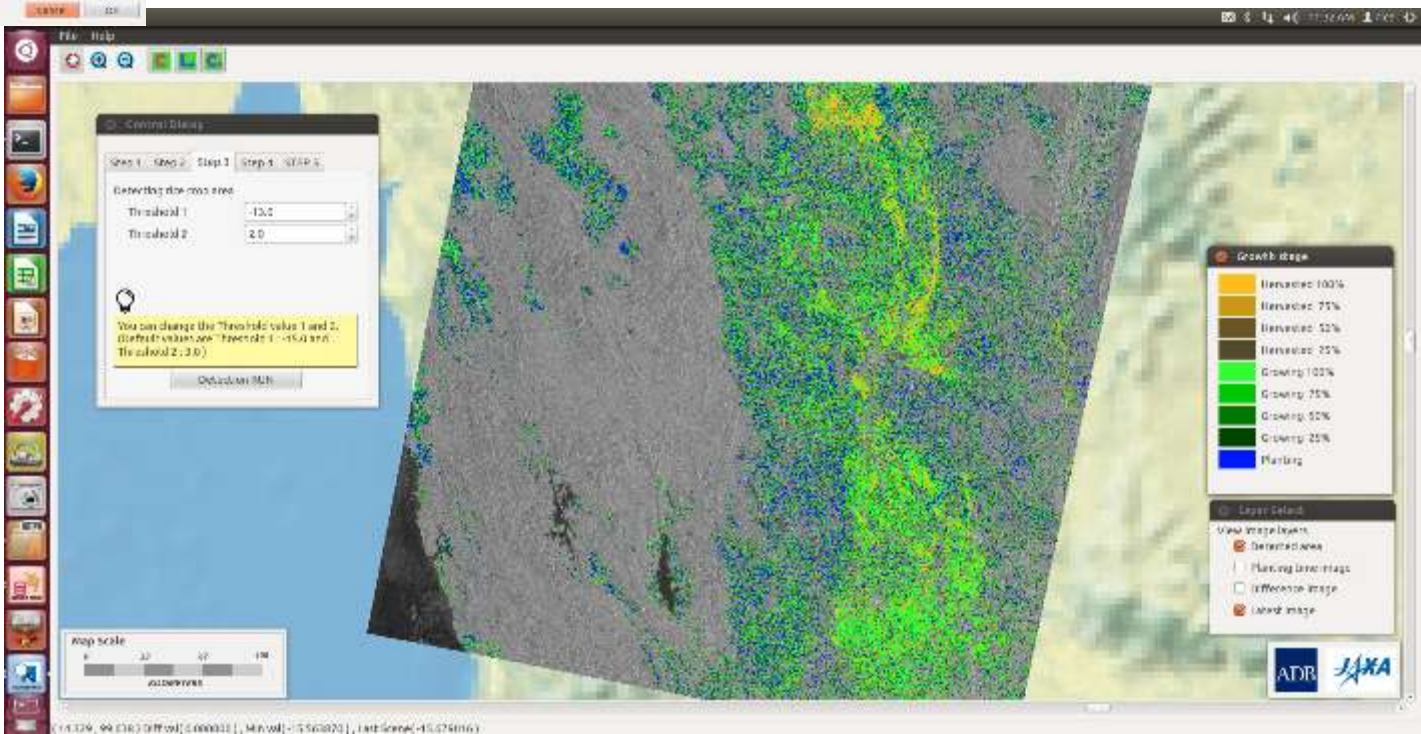
If (**Minimum** < Threshold1) and (**Range** > Threshold2) → **Rice Planted Area**
(Inundation stage?) (Vegetative stage ?)

RCDTA 8369:
Innovative Data Collection Methods for Agricultural and Rural Statistics

INAHOR-AD has been modified to identify not only rice area but also growing stages using time series SAR data.

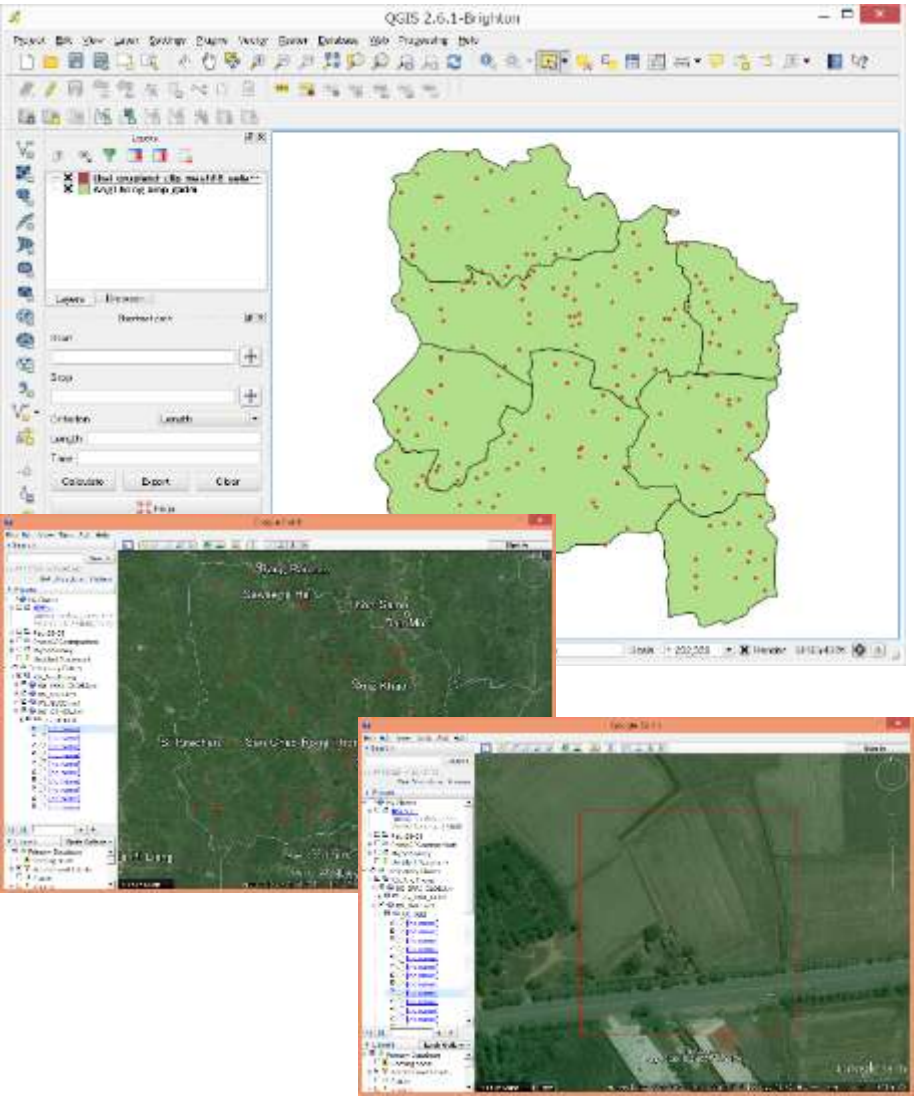


D1: Rice crop period (one rice crop cycle (default is 100 days)
D2: Period to use to check a planting season data for target season(default is 150 days)



RCDTA 8369:
Innovative Data Collection Methods for Agricultural and Rural Statistics

Field survey training for validation of planted area and growing stage with iPad and GIS software. (random sampling 120 points - paddy and non paddy area)



2016+ Plans and Expectations

- Continue working with Phase 1A/1B TDS to generate target products using SAR data from CEOS agencies including Radarsat-2, Sentinel-1, ALOS-2, CSK, TerraSAR-X , RISAT, etc. Continue working closely with CSA, DLR, ESA, JAXA, ISRO and other CEOS Agencies to ensure continuity of data supply for the TDS;
- Continue Sentinel-1 reference site work with GEORIICE, VAST, ESA and JAXA to explore the possibility of further expansion to other SE Asian sites. Continue working with GEORIICE to maximize the potential outcomes from the ESA DUE Innovator III program;
- Initiate integrated usage of HR optical and SAR for phenology studies (and others) using SPOT 5 Take 5, Venus, Landsat and Sentinel-2 data along with coarse resolution satellites such as MODIS and GCOM-C;
- Continue to work with AFSIS and international donors to promote the practical use of rice crop area and production estimates for outlooks in Asia (in cooperation with JECAM, AFSIS, ESCAP, MRC, APRSAF, SERVIR MEKONG, etc.); - JECAM SAR study
- Define a standard field survey procedure;
- Jointly publish Asia-RiCE TDS results and hold Asia-RiCE meetings/workshops in conjunction with international conference such as ACRS.

GEOGLAM
Global Agricultural Monitoring

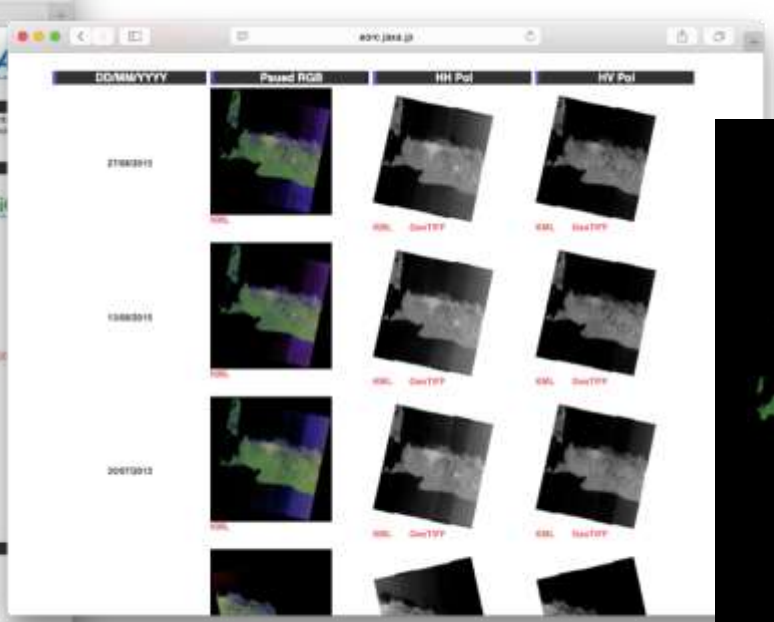
Asia-RiCE
Crop Estimation and Monitoring

Asia-RiCE ALOS-2 Data Distribution System

- ALOS2 data are provided under the framework of K&C (Kyoto & Carbon) initiative via JAXA/EORC web server for authorized Asia Rice partners and JECAM Argentine
- This data distribution include JECAM site in Argentine and Chinese Taipei (Taiwan).

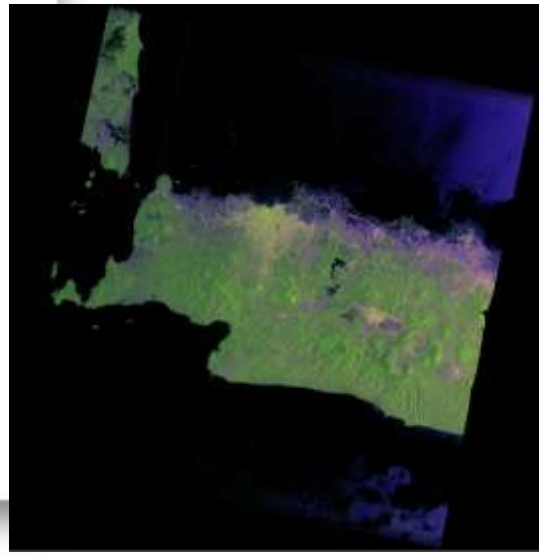
Top Page (11 regions/countries)

Data Catalog



GeoTiFF +

KML



http://www.eorc.jaxa.jp/paddy/Asia-RiCE/ALOS2/index.php

CEOS Coordination – Data Acquisition Requests

1. **Dataset 1: SAR**
    1) Rainy season; May - Oct, 2016
    2) Dry season Nov 2016 - April 2017

Temporal Resolution: 14-30 days (14 days is optimal but 24 - 30 days is still acceptable)
Spatial Resolution: 20-100m
Spectral: C & L band RADAR, dual polarization VV/VH or HH/HV

2. **Dataset 2: Optical and NDVI**
    1) Rainy season; May - Oct, 2016
    2) Dry season Nov 2016 - April 2017

Temporal Resolution: 14 days (reasonably cloud free)
Spatial Resolution: 20-500m
Spectral: Optical (e.g. MODIS, GCOM-C, Landsat 8, Sentinel-2, SPOT-5)

3. **Dataset 3: Agromet info**
    1) Rainy season; May - Oct, 2016
    2) Dry season Nov 2016 - April 2017

Temporal Resolution: Monthly
Spatial Resolution: 20-500m
Spectral: Microwave (GCOM-W, SMAP, SMOS, GPM, etc.) – precipitation, soil moisture, LST, PAR, NDVI

CEOS Coordination – Target Areas

1. **TDSs (provincial-level, 100km x 100km)**

2. **Wall-to-wall**

Candidates: Thailand, Vietnam (Mekong + Red river (south and north main area) and Indonesia (top 10 rice producing provinces).

The Indonesian MOA will perform field surveys for the top 10 provinces.
GEORIICE and VAST will do field surveys in the Mekong Delta.
GISTDA will be doing field surveys in the main rice crop provinces.

3. **Current issues**

Sentinel-1 observation has a gap in Thailand. However, observations are made every 24 days in the main crop area (central plains).

ALOS-2 observations are lacking for some TDS.

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Asia-RiCE Strategic Issues

- **Secure observation, continued and easy data access:** Share observation / acquisition plan of multiple satellites at one site to conduct information validation for rice growing and production estimation (especially for wall-to-wall (whole country – country scale) starting from main crop area of Indonesia, Vietnam, and Thailand) in cooperation with CEOS
- **Need Support ICT environment with applications for data archive and processing**
- **Expand SDMS / cloud computing system to do practical use for end users such as Ministries of Agriculture**
- **Promote EO data and related information sharing** (especially ground base data and base line map such as LULCC / rice crop mask, rice crop calendar, etc.)
- **Promote cross validation** for outlook and rice crop growing and production estimation
- **Promote regional coordination** (need donor such as ADB, UN-ESCAP, MRC, CEOS, and GEO support, and contribution/endorsement from national monitoring systems)
- **Sustained institutional support to promote satellite data usage & validation** (many Asian countries are developing countries)

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Conclusion

- Promote regional work through inviting international donors, CEOS and GEO organizations and in-kind contribution from countries with high level governmental officers endorsement
- Continue working with Phase 1 of TDSs to generate target products using SAR data and optical sensors and scale up from TDSs to wall-to-wall (whole country)
- Continue working for rice crop outlook in cooperation with AFSIS

http://www.earthobservations.org/geoglam

http://www.asia-rice.org

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Thank you