ALOS Kyoto & Carbon Initiative 23rd Science Team meeting (KC#22)

Asia-RiCE: Rice Crop Estimation and Monitoring (the role of PALSAR-2)

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On behalf of Asia-RiCE team

January 18, 2017
at TDU Hatoyama Japan

GEOGLAM
Global Agricultural Monitoring

Asia-RiCE
Crop Estimation and Monitoring

Contents

- Introduction of Asia-RiCE
- Introduction of INAHOR Software
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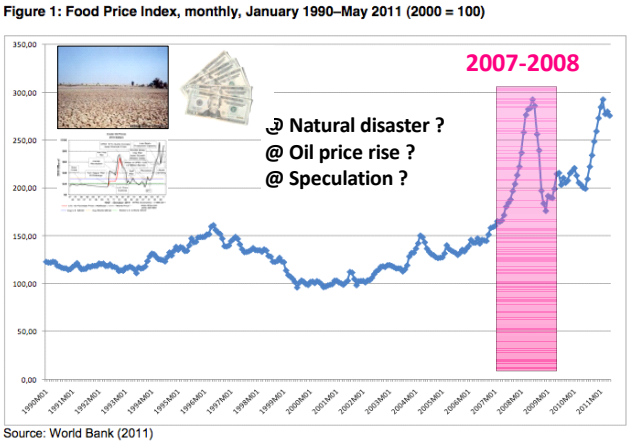
Introduction of Asia-RiCE

Introduction of Asia-RiCE

- Asia-RiCE was launched by JAXA with collaborative effort between a number of Asian organizations, in order to contribute to AMIS / GEOGLAM which were launched under the agreement of G20 Agriculture Ministers at the G20 France summit 2011.
- Asia-RiCE are working to develop a methodology for monitoring Asian rice since rice is the main commodity crop in Asia.
- The aim is to provide accurate / objective information to the market through the AMIS / GEOGLAM.



* AMIS: Agricultural Market Information System
* GEOGLAM: Group on EO – Global Agricultural Monitoring

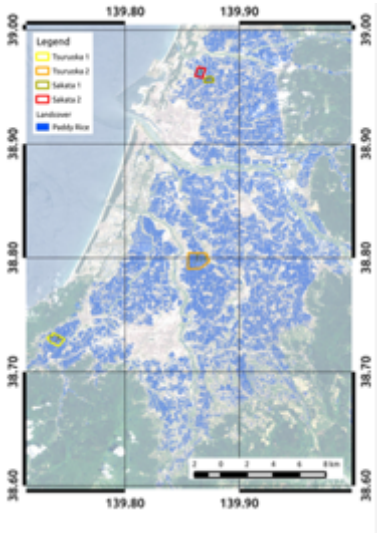
Asia-RiCE Home Page – www.asia-rice.org

For more information, please visit our home page.

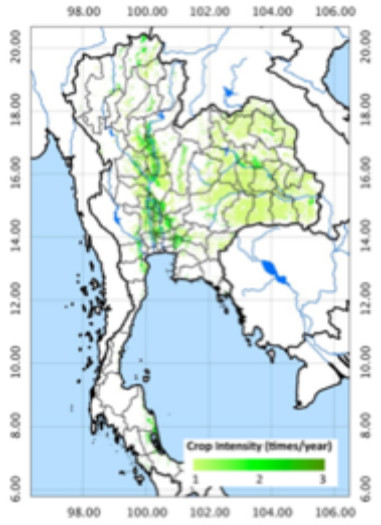
Asia-RiCE Target Products

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

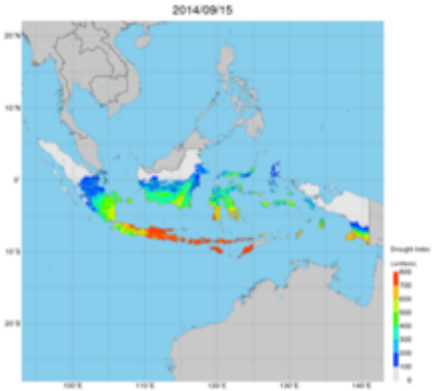
Example of Products



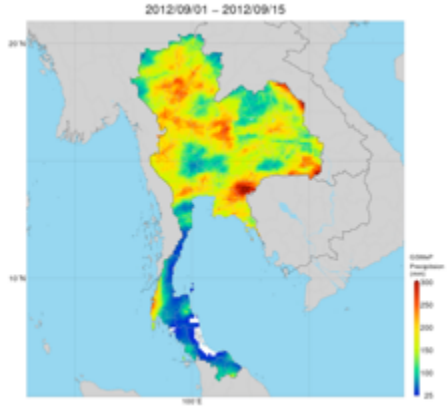
P1: Planted Area



P2: Crop Calendar



P3: Drought Warning



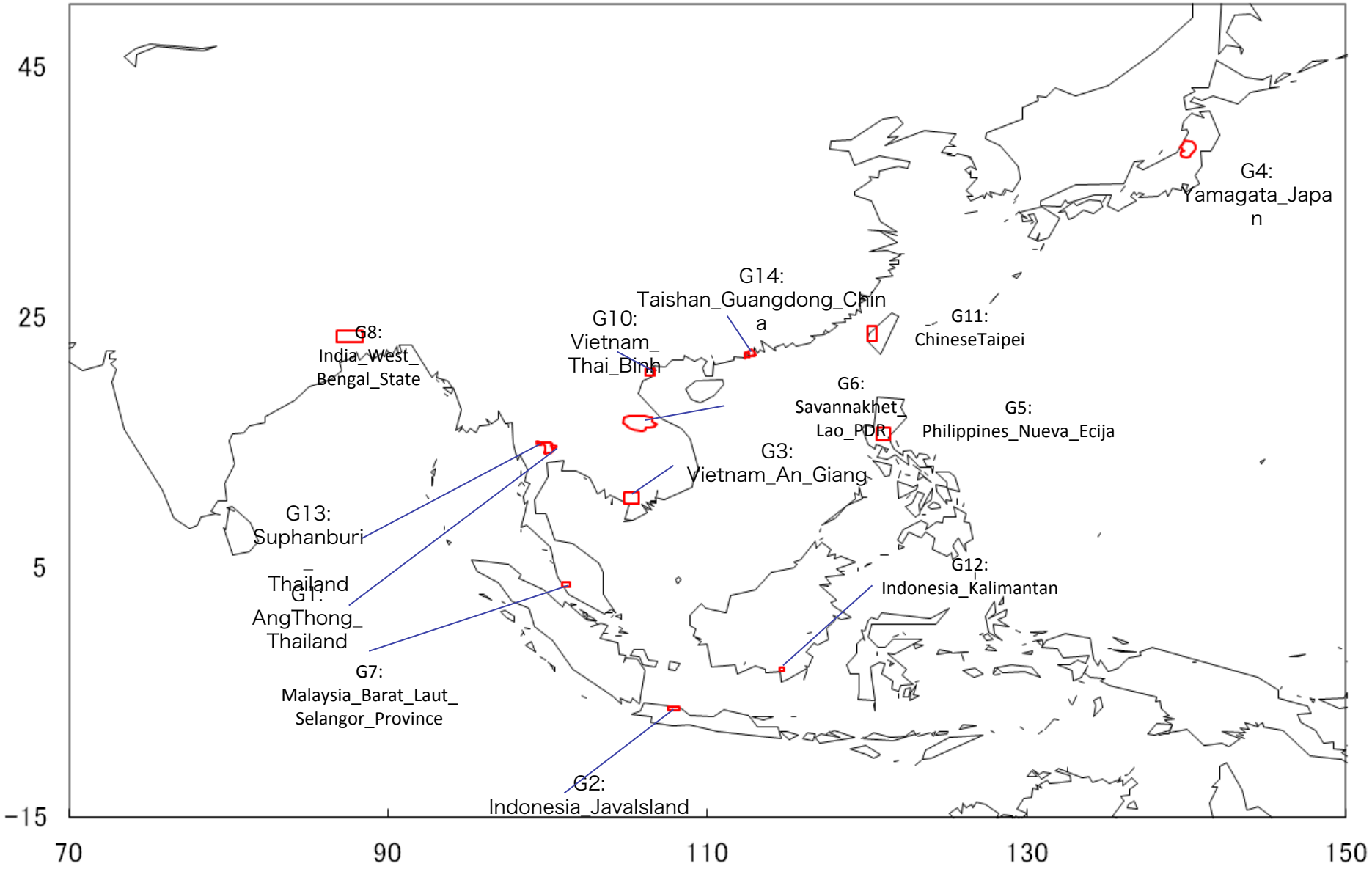
P4: Precipitation

Asia-RiCE Work Plan http://www.asia-rice.org/files/workplan.pdf

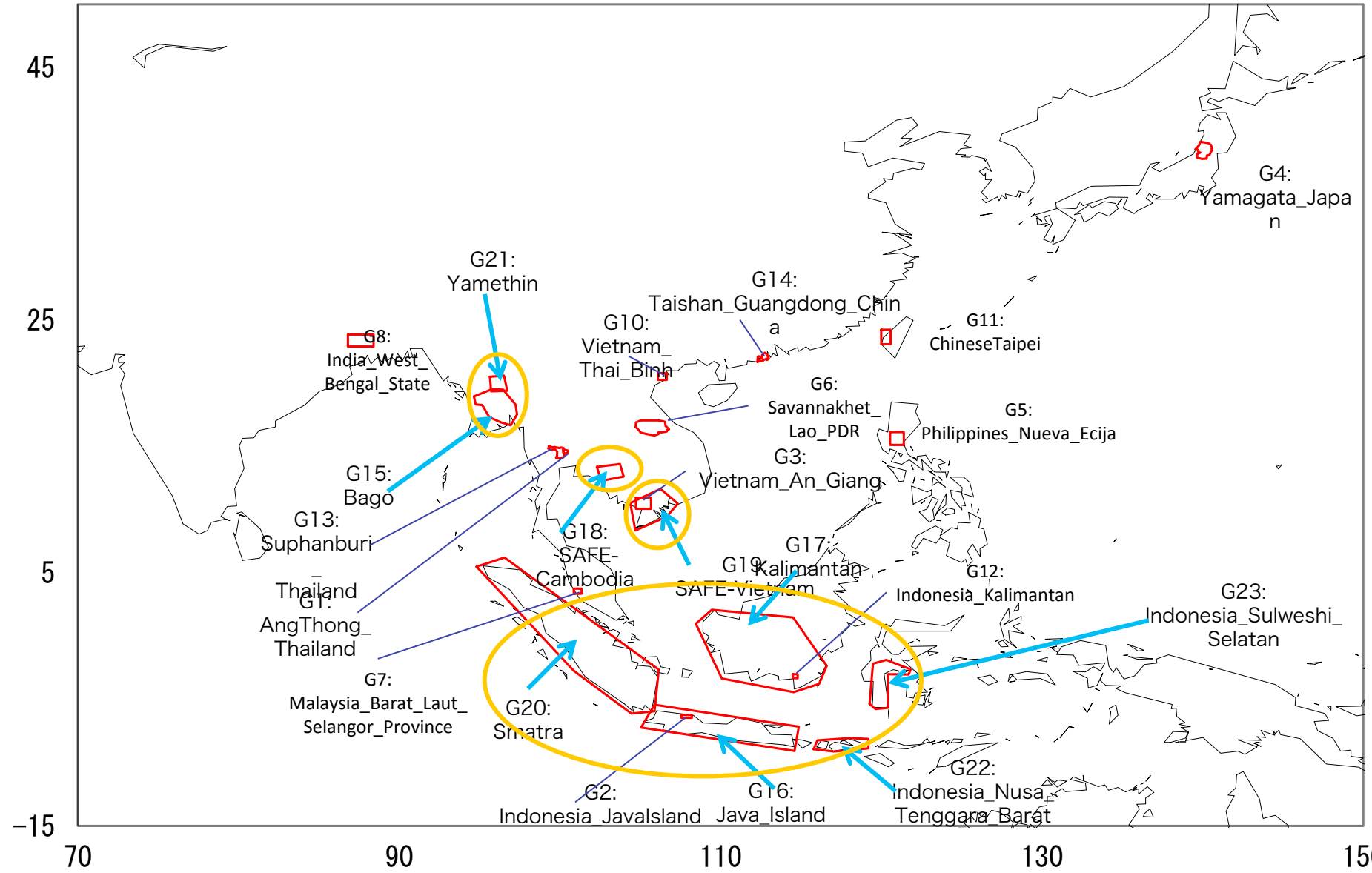
Asia-RiCE Crop Estimation and Monitoring

Asia-RiCE Technical Demonstration Sites (TDS)

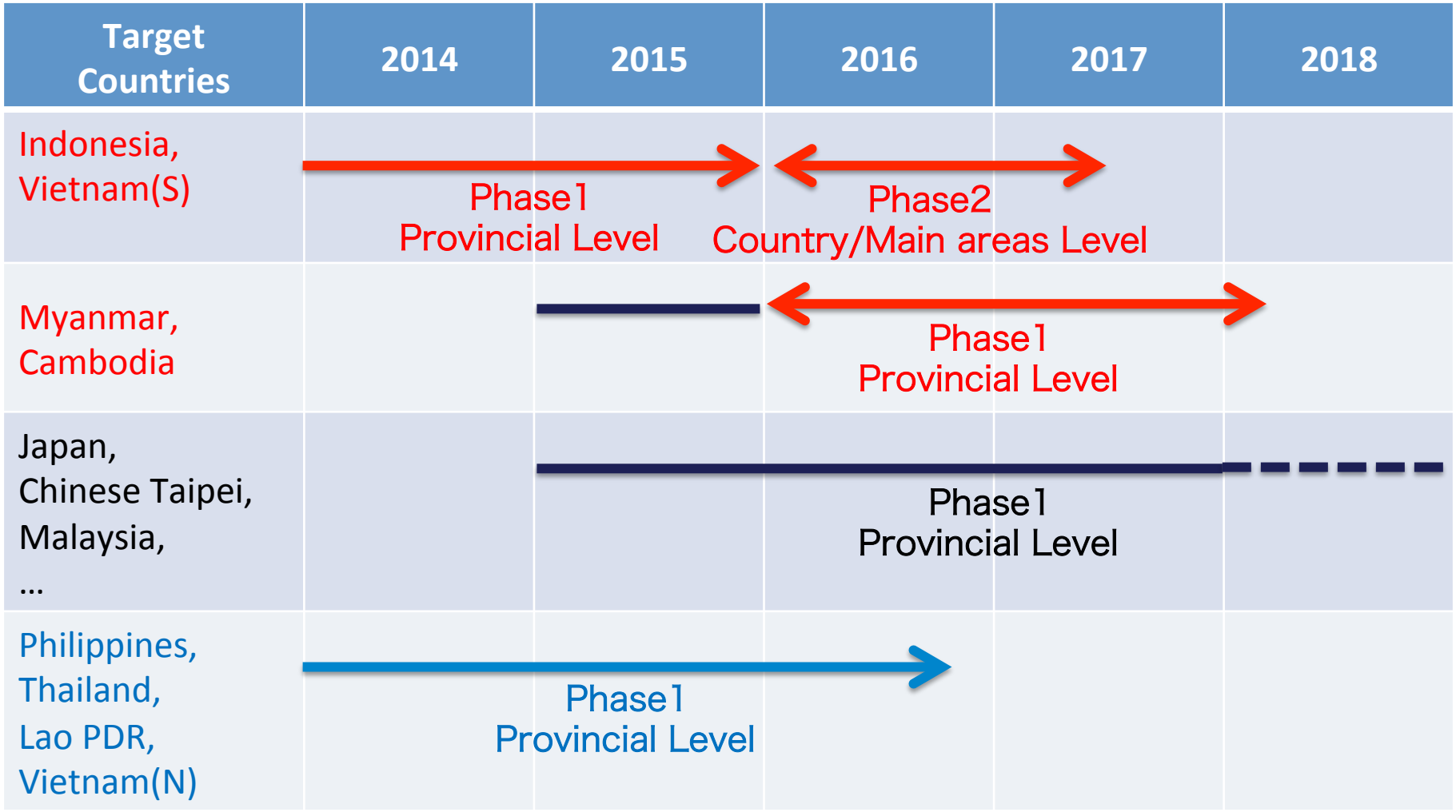
PALSAR-2 observation request in 2015 for Asia-RiCE Technical Demonstration Sites



PALSAR-2 observation request in 2016 for Asia-RiCE Technical Demonstration Sites



Asia-RiCE Progress schedule



- SAFE (Space Applications for Environment) Project under APRSAF (Asia-Pacific Regional Space Agency Forum)
- ADB (Asian Development Bank) Project *related activity
- Individual activity by each country

Introduction of INAHOR Software

Rice planted area/production estimation software

JAXA developed a software named INAHOR which can estimate rice planted area and production using SAR data,
In order to standardize a methodology for monitoring rice using satellite data in Asian countries.

INAHOR :

INternational Asian Harvest mOnitoring system for Rice
(and “INAHO” also means “rice year” in Japanese)

The main functions :

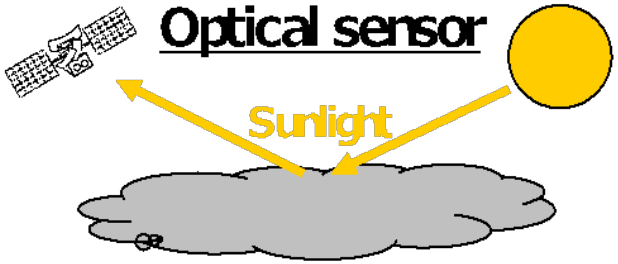
- Providing a rice planted area map (including the growing stages classification)
- Providing a rice planted area and production (need yield information)

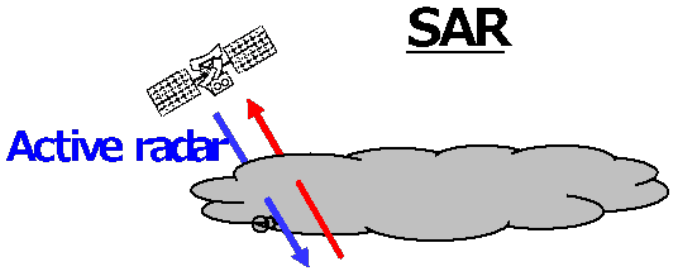
Input satellite data :

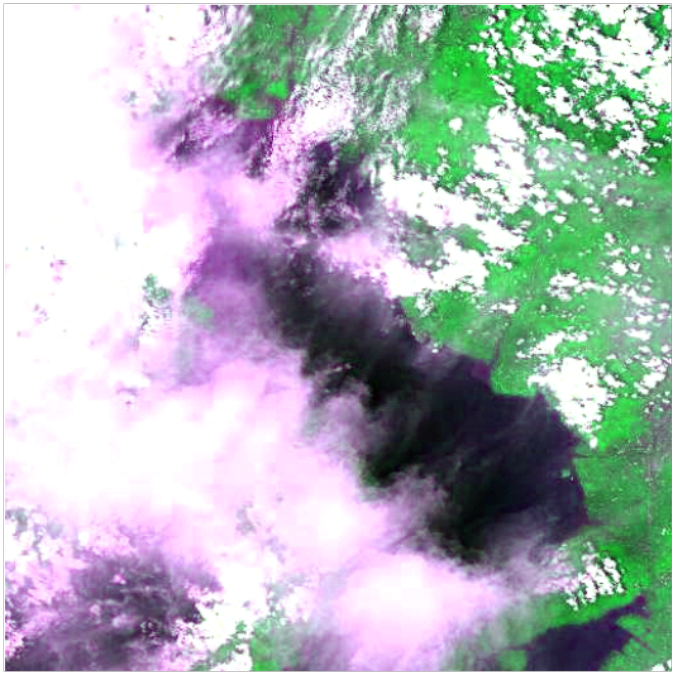
Time-series SAR data (ALOS PALSAR,
ALOS-2 PALSAR-2, RADARSAT-2, Sentinael-1)

Advantage of synthetic aperture radar (SAR)

SAR is useful in Asian countries which have a lot of cloud, since microwave can penetrate the cloud.

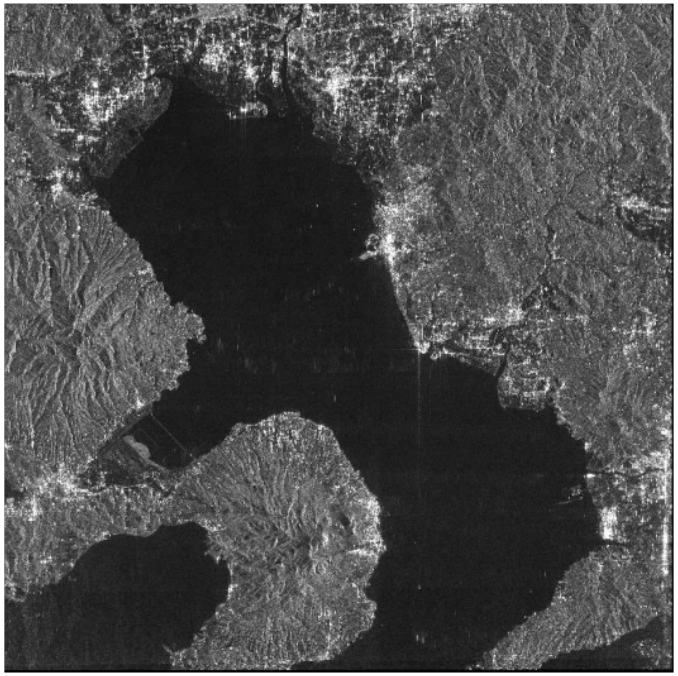






ALOS AVNIR-2 : The cloud covers the ground in the optical sensor image.

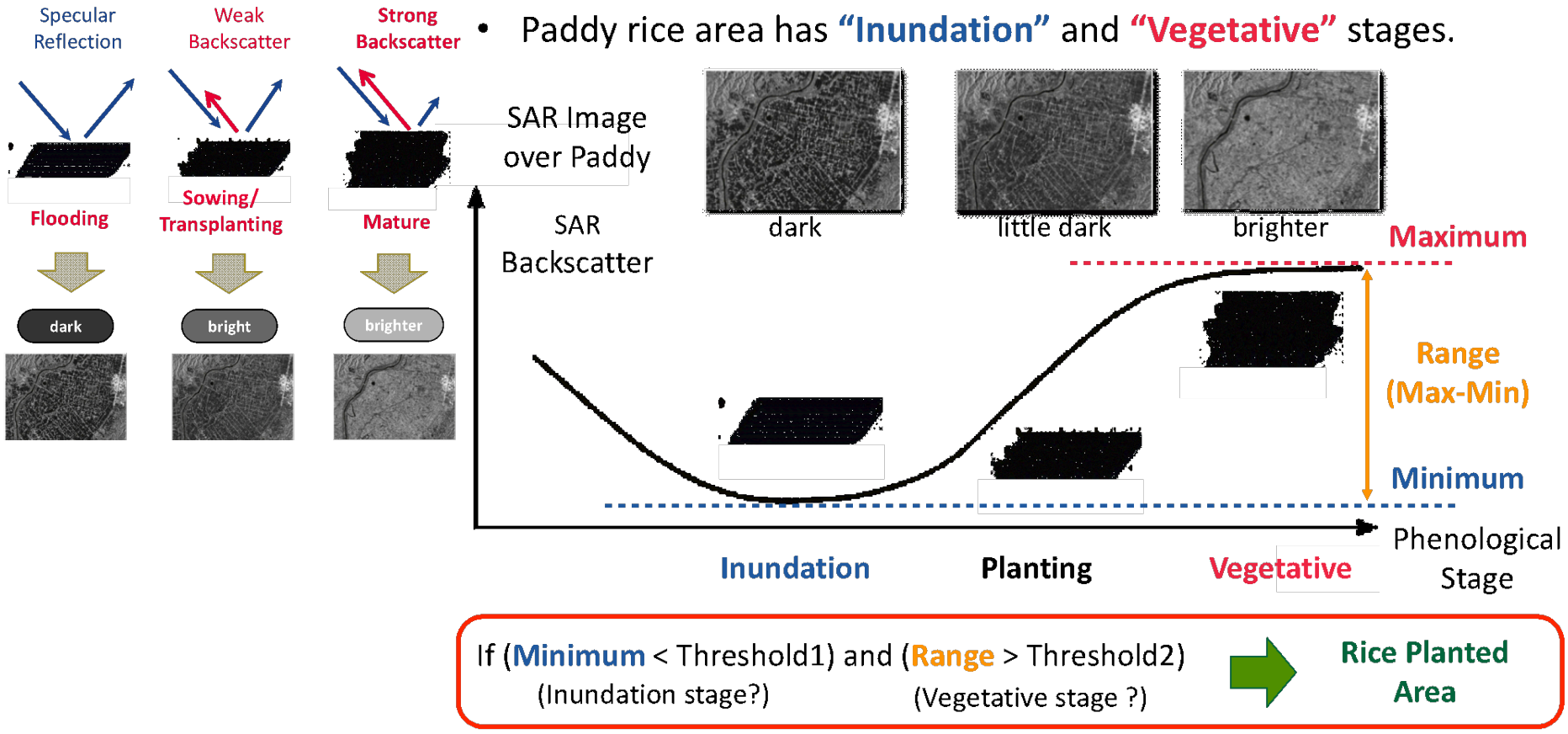
Observed simultaneously



ALOS PALSAR : SAR can observe the ground under the cloud.

Basic concept for identifying rice planted area

Rice area can be identified by analyzing characteristics which is the change of backscatter at rice field with time-series SAR data.
The area where is dark in planting stage and becomes brighter in vegetative stage is paddy field.



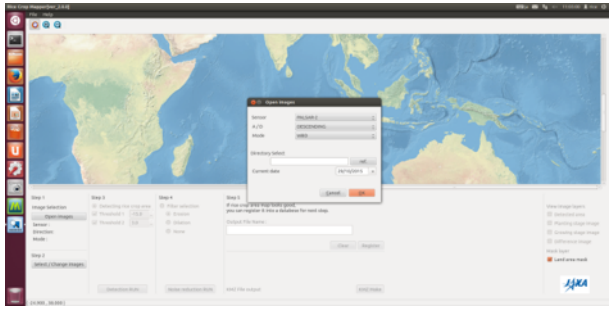
Rice planted area/production estimation software

Significant feature in the design of INAHOR :

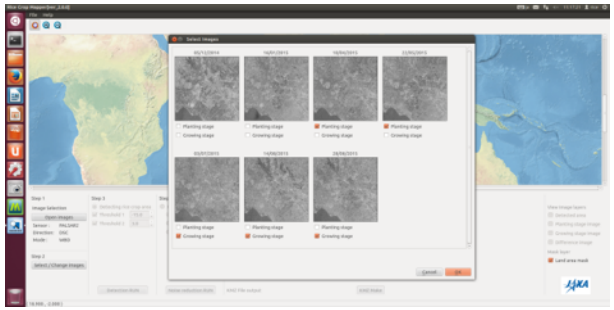
The software was designed for a local officer so that they can get easily the useful information from satellite data.

You can get the rice mapping result, only 5 steps, from open the data until save the result.

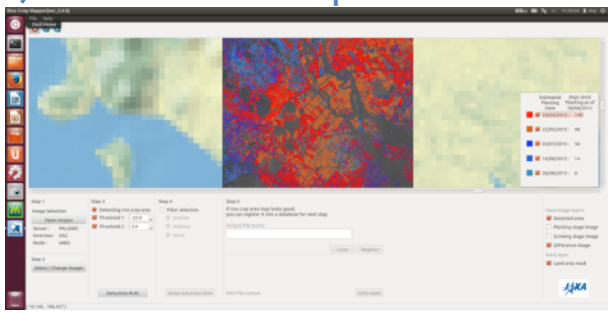
1) Select satellite data



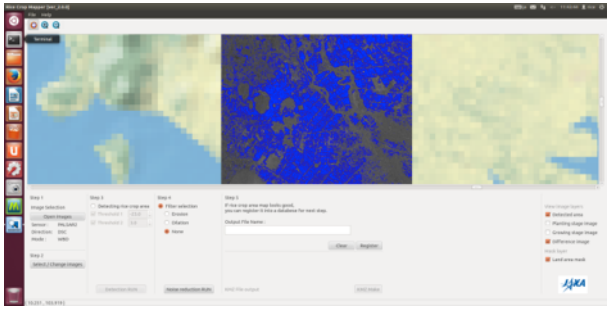
2) Select image data



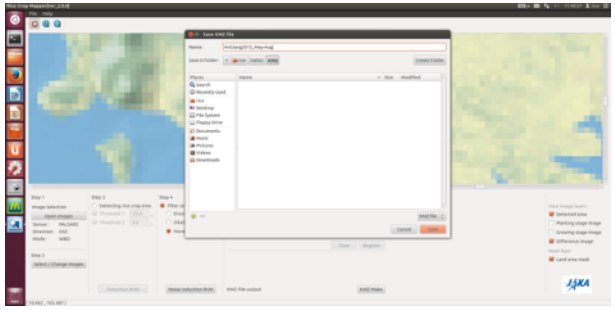
3) Detect rice planted area



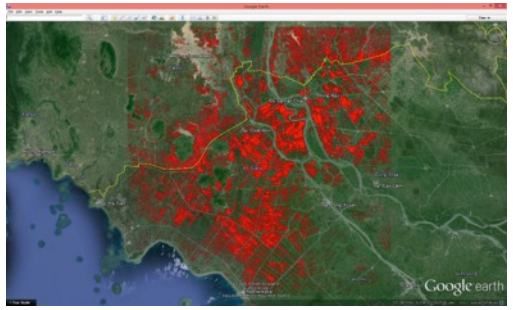
4) Binarization



5) Save the result



Export to KMZ



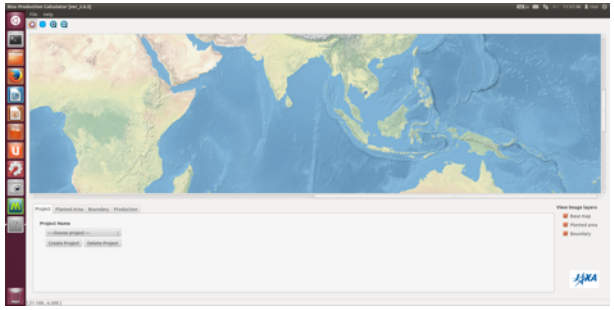
Rice planted area/production estimation software

Significant feature in the design of INAHOR :

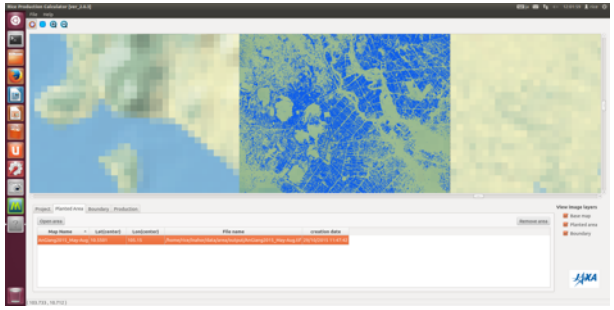
After rice crop mapping, you can get the planted area and the production easily.

The calculating procedures are 5 step only as well.

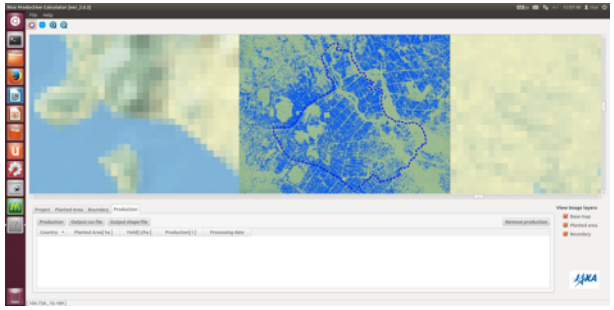
1) Launch calculator



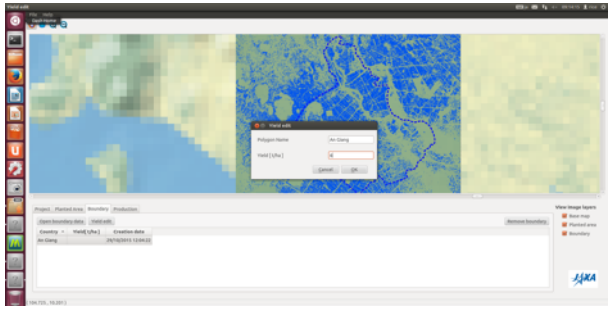
2) Load the rice map



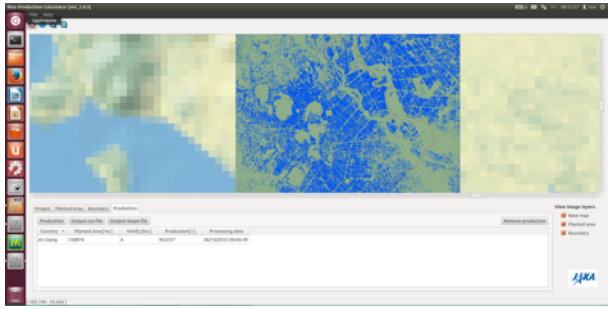
3) Load a boudary



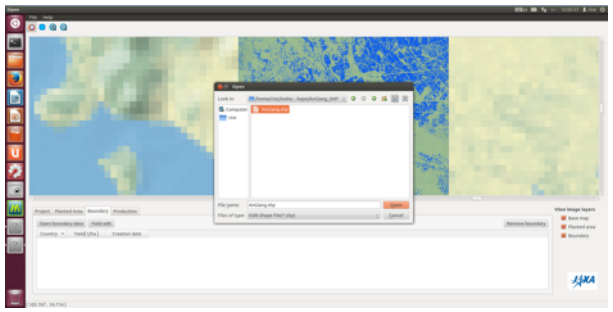
4) Input yield data



5) Calculate area & production



Export to shp and csv



Implementation status in Indonesia by MOA

Indonesia, phase 2

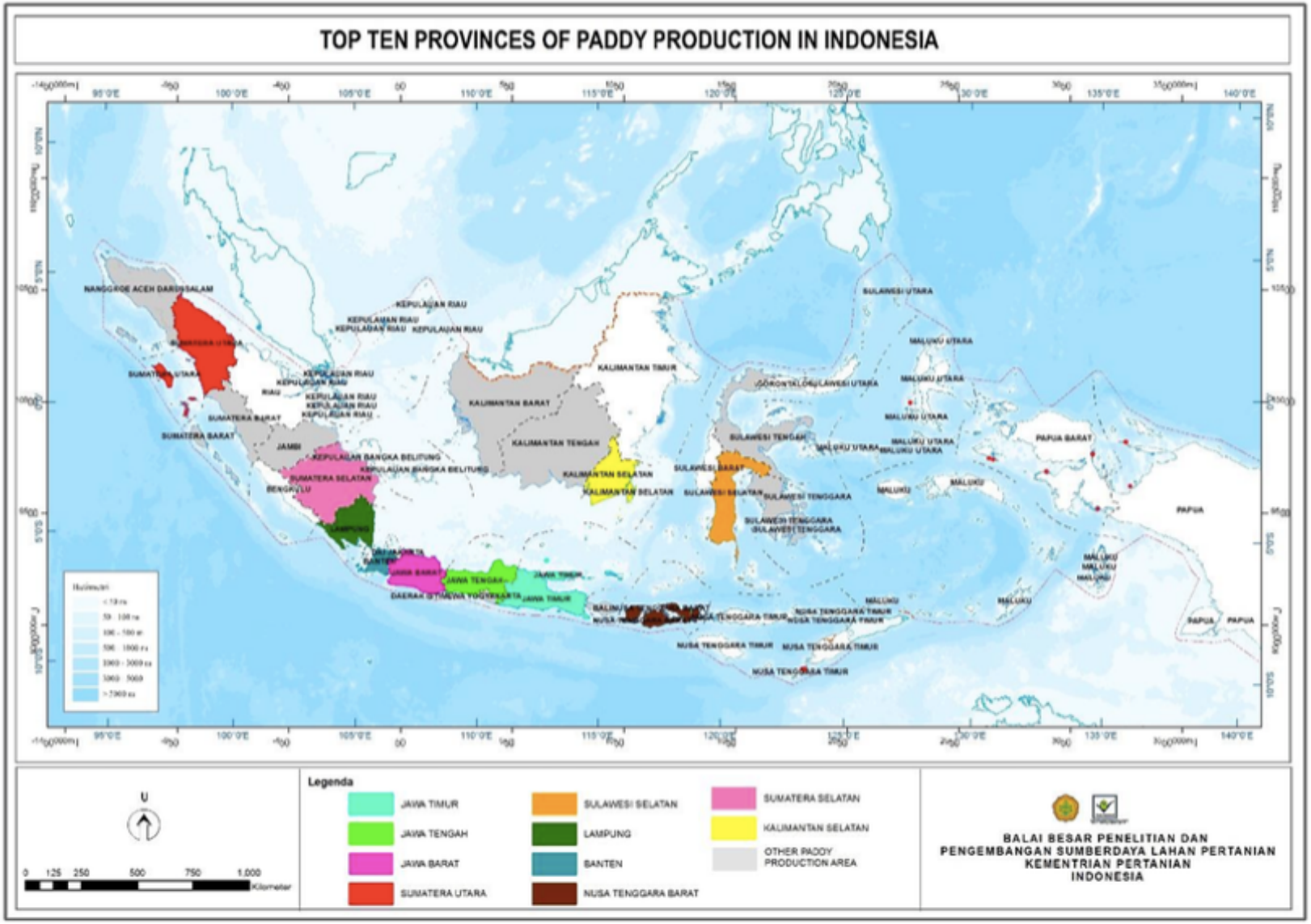
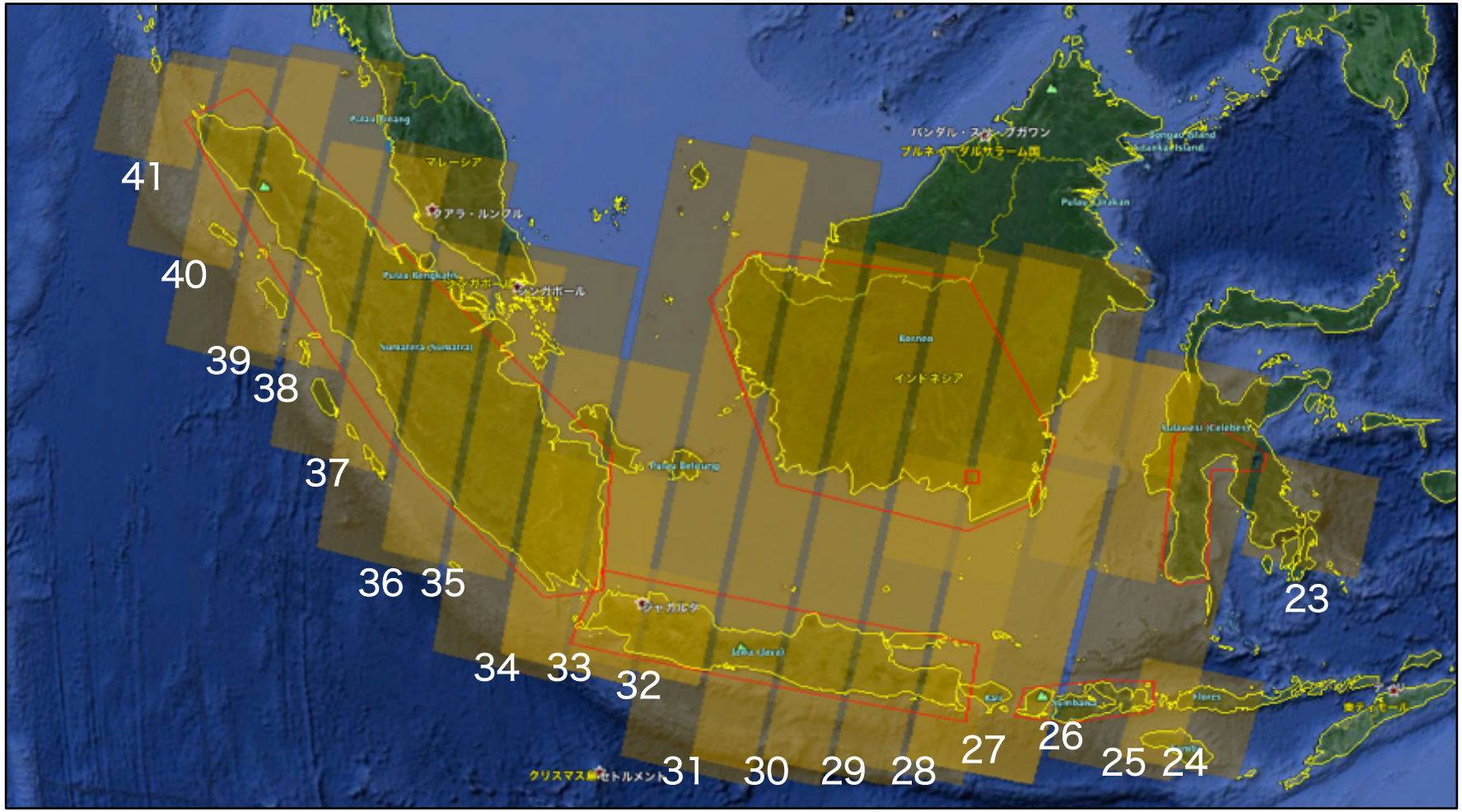


Figure 1. selected 10 top provinces for upscaling of SAR modeling of paddy

Indonesia, phase 2

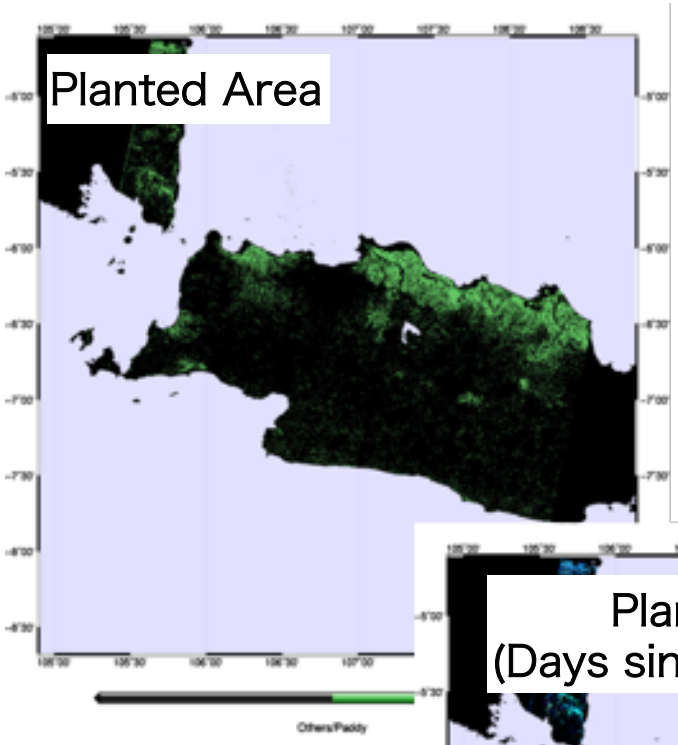


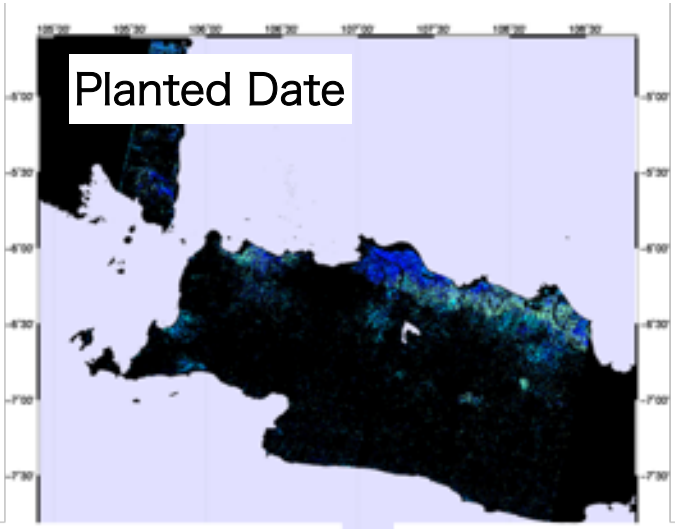
Indonesia, phase 2

Figure 1. selected 10 top provinces for upscaling of SAR modeling of paddy

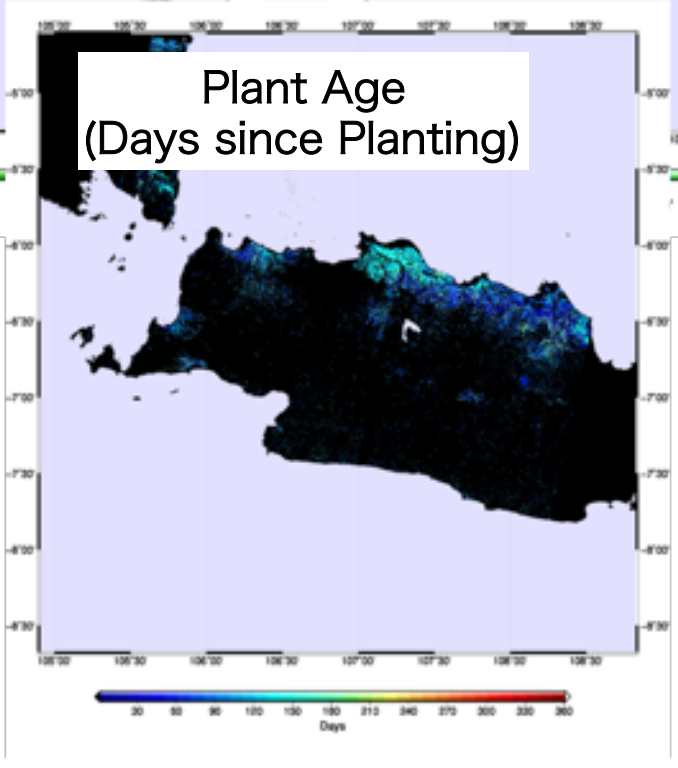
3000 km

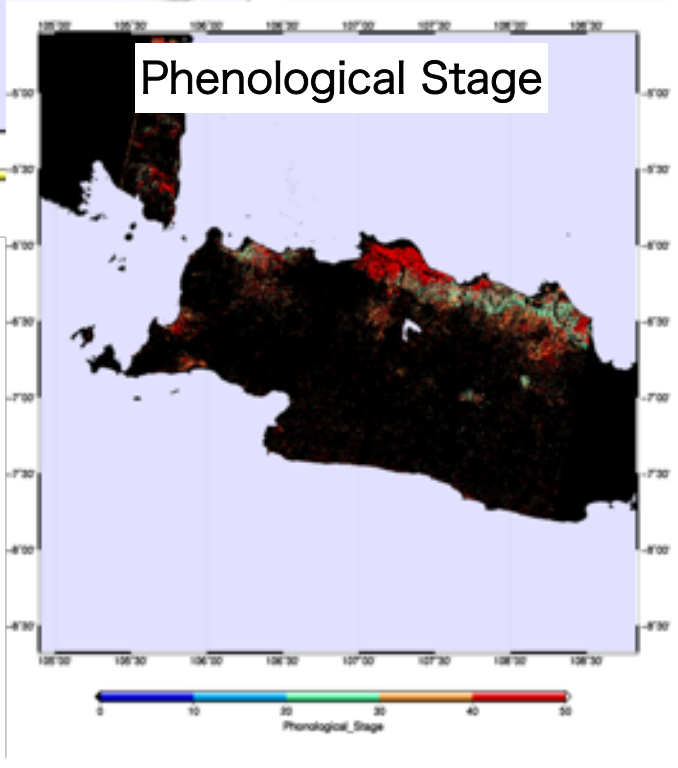
Indonesia, phase 2





As of
22 Jul 2016





Implementation status in Vietnam (S) by VNSC

Vietnam (S), phase 2

Introduction

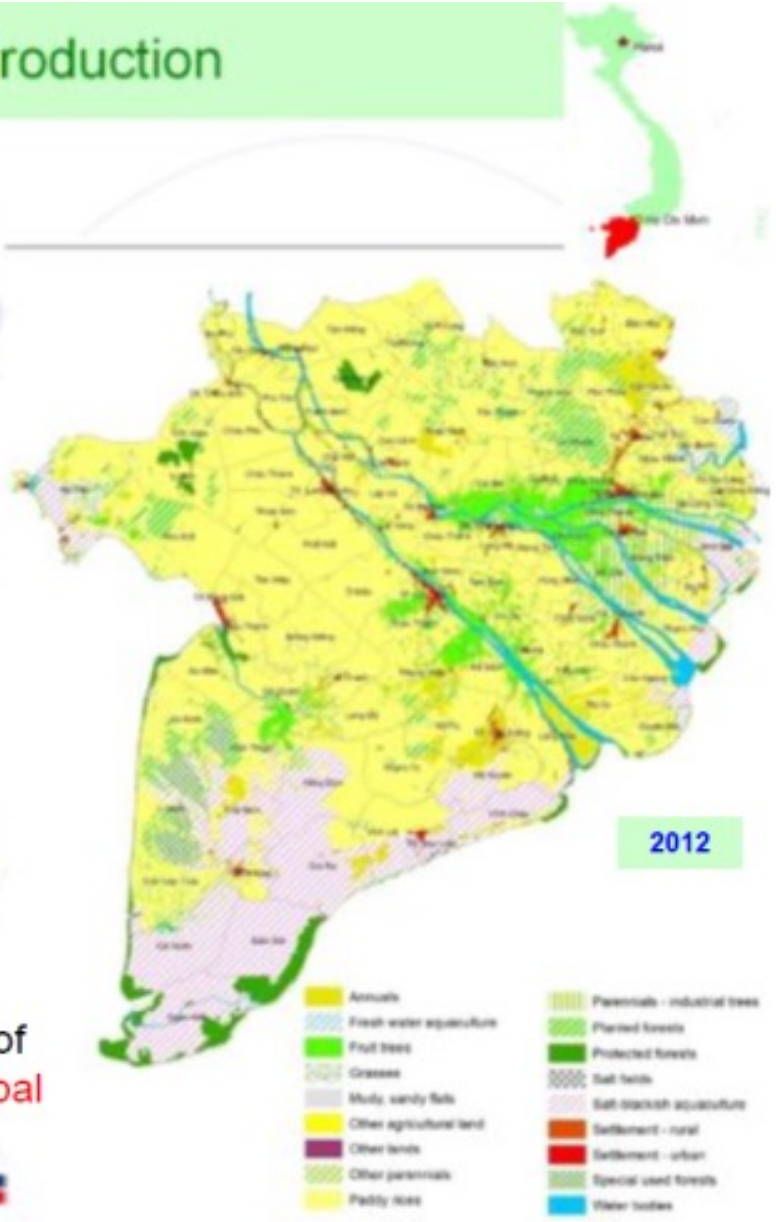
Source: Parry, M.L. et al., 2007

Mekong Delta (Source: GSO, 2015)

- Area: 40,576 Km2 (1/8)
- Population: 17.590 M (~1/5)
- MD accounts for more than half (25.7 / 45.2 Mt) of the country's rice production (>1/2)

→ Food security

The Mekong Delta, South of Vietnam is one of the most affected regions in the world by global warming.



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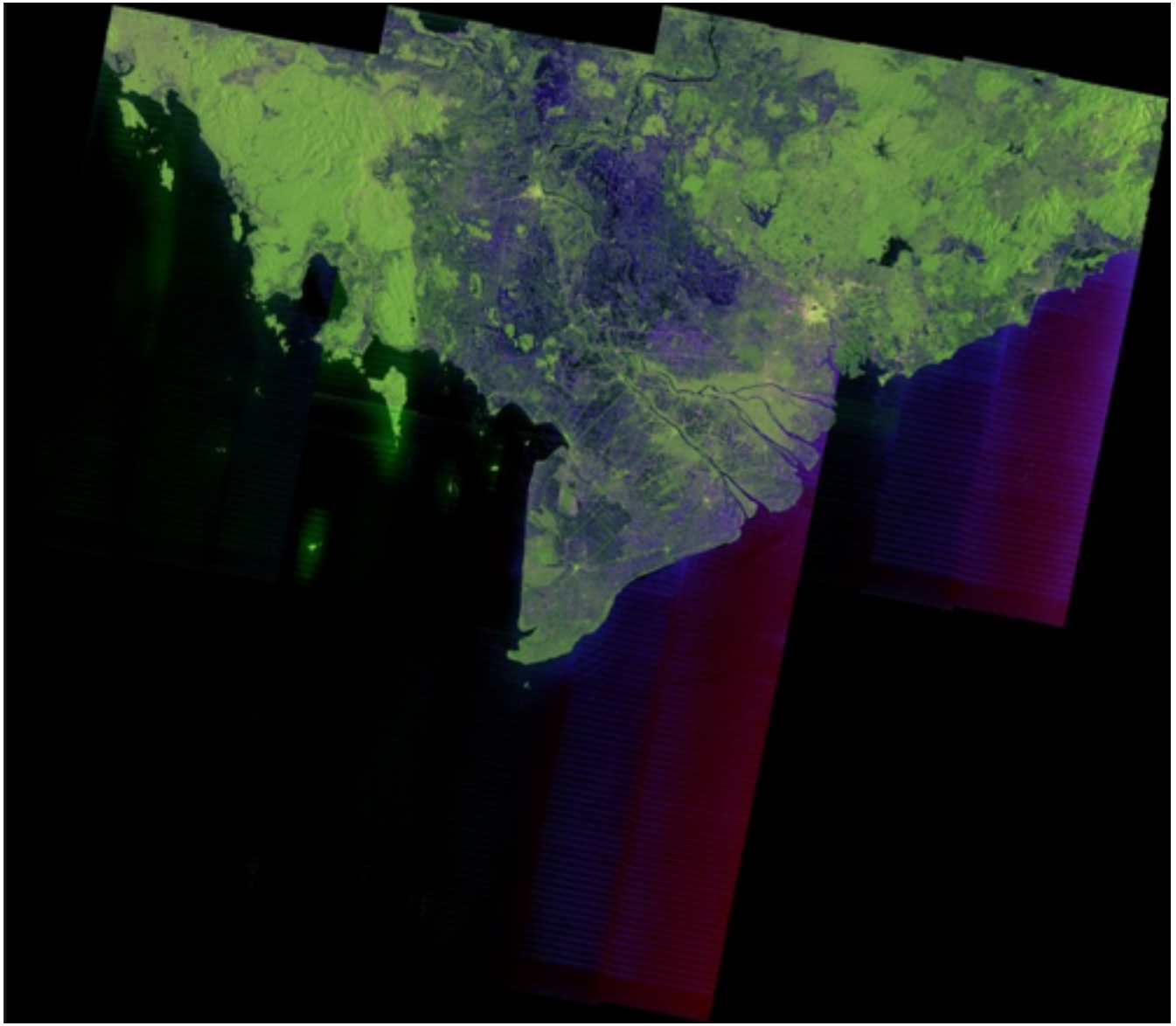
Vietnam (S), phase 2

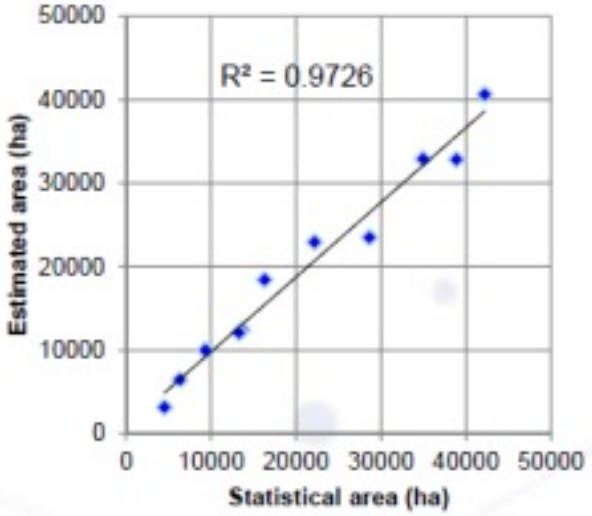


Vietnam (S), phase 2

Data set: ALOS-2, 2016

SA 2016 crop (using 5-date ALOS-2 HH image, 08 Apr, 20 May, 01Jul, 29Jul, 09 Sep)

District	Agency data (ha)	Estimated area (ha)	Percentage error (%)
An Phu	13640	12431	-8.9
Cho Moi	13304	12080	-9.2
Chau Phu	34940	32921	-5.8
Chau Thanh	28630	23507	-17.9
Phu Tan	22151	22962	3.7
Tinh Bien	16288	18441	13.2
Chau Doc	6315	6445	2.1
Long Xuyen	4518	3153	-30.2
Thoai Son	38882	32846	-15.5
Tri Ton	42210	40625	-3.8
Tan Chau	9321	10007	7.4
Total	**230199**	**215418**	**-6.4**

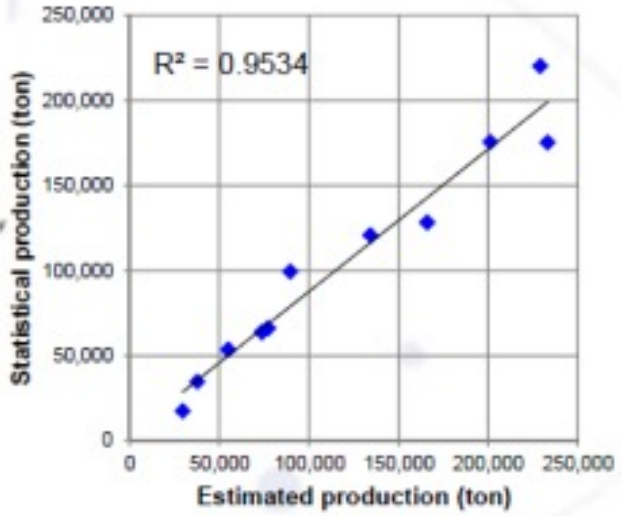


Vietnam (S), phase 2

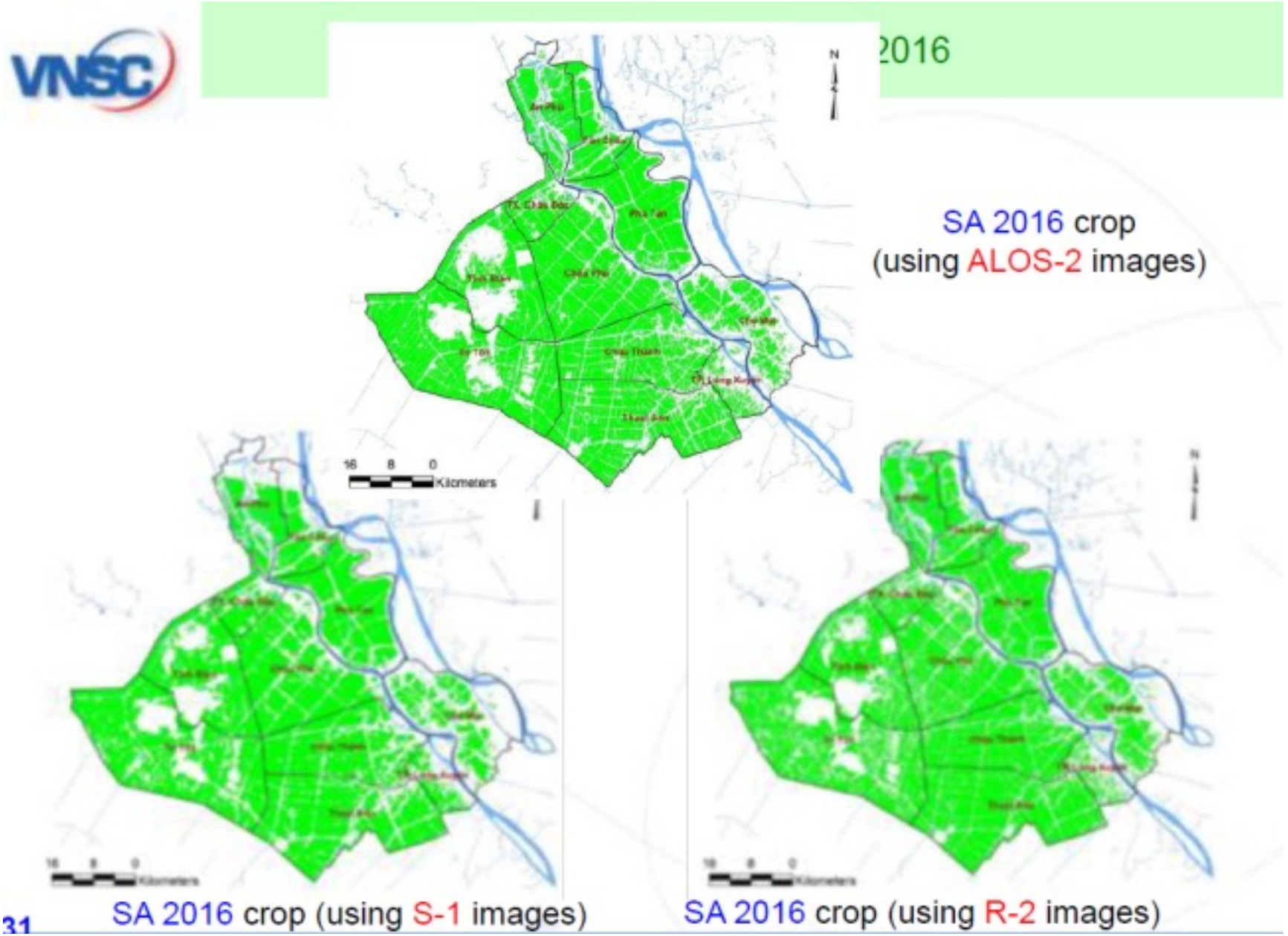
Data set: ALOS-2, 2016

A distribution map of estimated rice yield of An Giang in SA 2016 crop using ALOS-2 data

District	Agency data (ton)	Estimated production (ton)	Percentage error (%)
An Phú	73,656	63,717	-13.5
Chợ Mới	77,296	66,103	-14.5
Châu Phú	201,254	175,556	-12.8
Châu Thành	166,054	128,187	-22.8
Phú Tân	134,457	120,703	-10.2
Tịnh Biên	89,584	99,328	10.9
Châu Đốc	37,890	34,638	-8.6
Long Xuyên	29,503	17,422	-40.9
Thoại Sơn	233,292	175,277	-24.9
Tri Tôn	229,200	220,147	-3.9
Tân Châu	54,994	53,576	-2.6
Total	**1,325,946**	**1,154,655**	**-12.9**

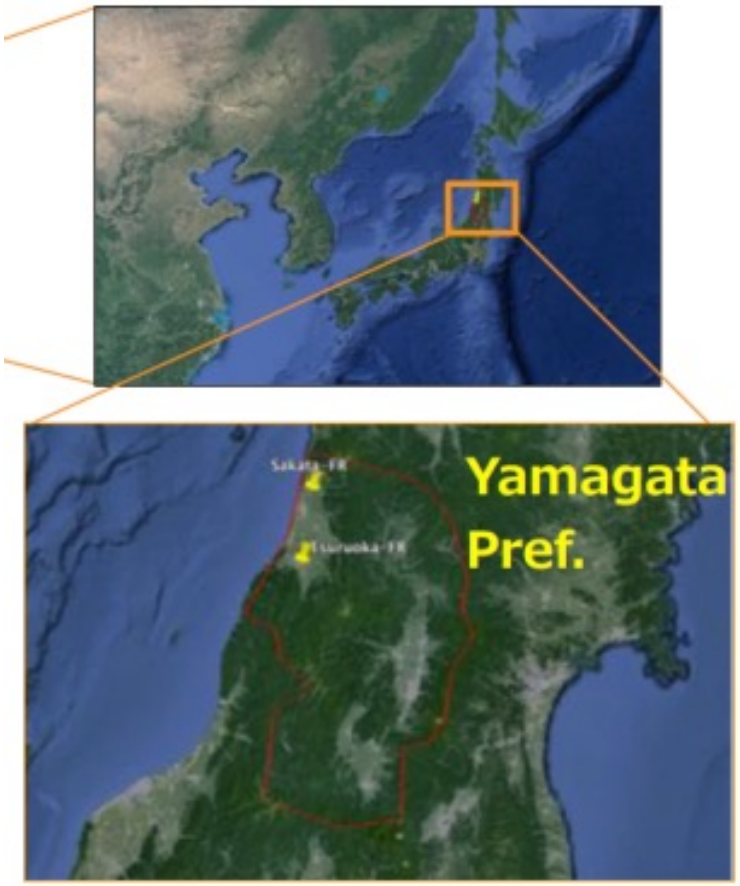


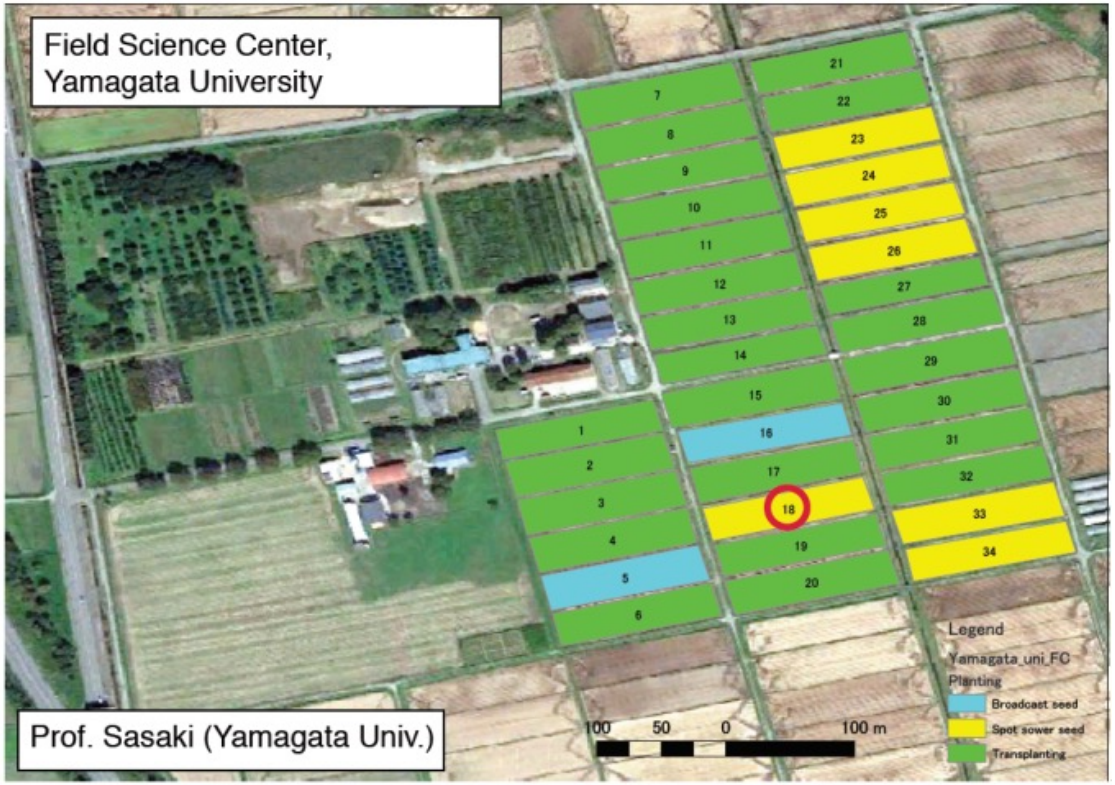
Vietnam (S), phase 2



Implementation status in Japan by JAXA

Japan, phase 1



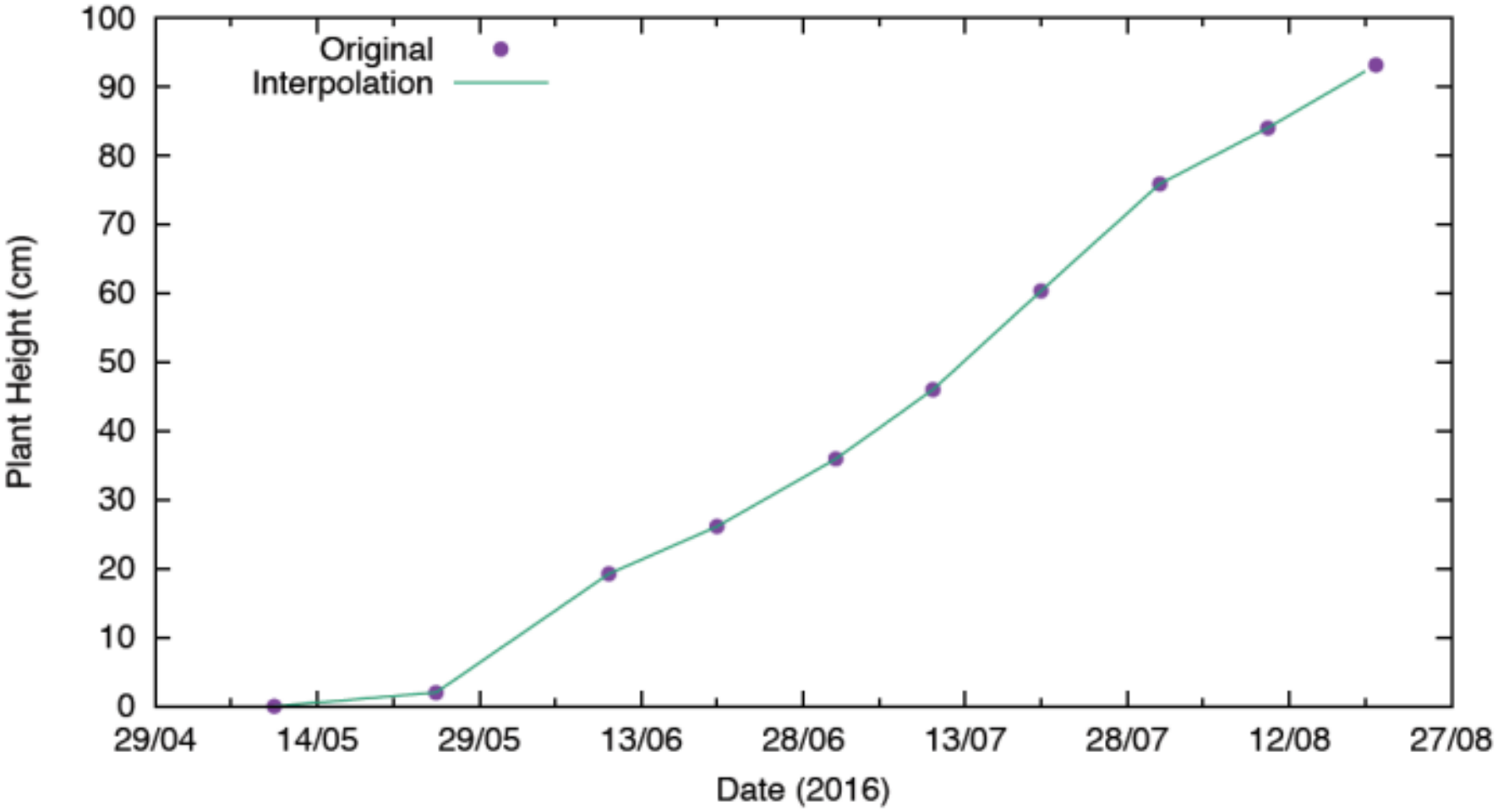


Rice Crop Calendar in Yamagata Prefecture

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Calendar					Planting				Harvesting			

Japan, phase 1

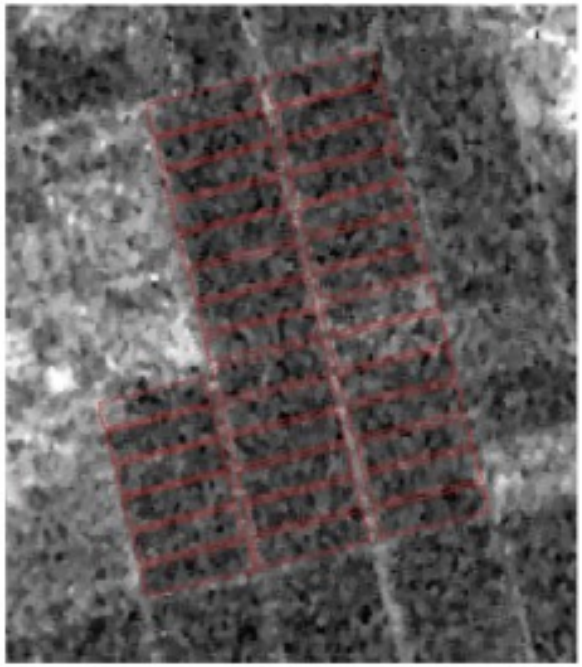
- Yamagata Univ., Tsutuoka City, Yamagata Pref., Japan



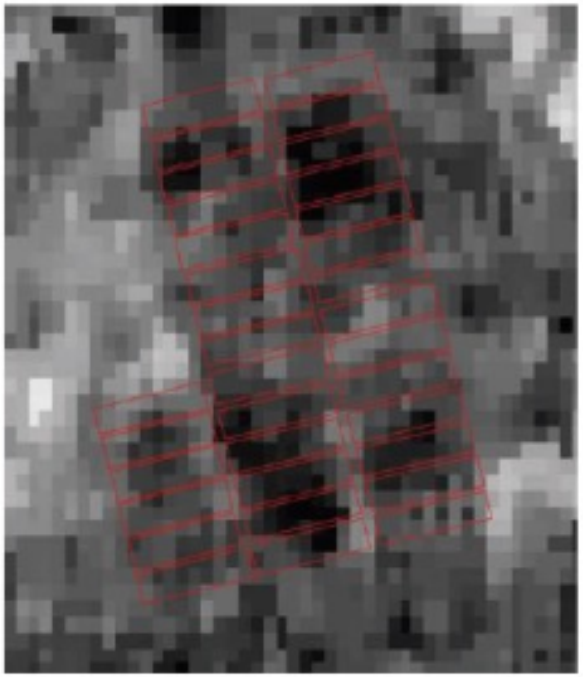
Japan, phase 1

Sensor (Mode)	ALOS-2 (Fine)	Sentinel-1 (Interferometric Wide Swath)	Radarsat-2 (Wide Fine)
Frequency	1.25 GHz **(L-Band)**	5.405 GHz **(C-Band)**	5.405 GHz **(C-Band)**
Spatial Resolution (Pixel Spacing)	3.0 m (2.5m)	5 x 20 m (10.0m)	5.2 x 7.7 m (8.0m)
Polarization	HH	VV	VV, VH
Swath	50 km	250 km	150 km

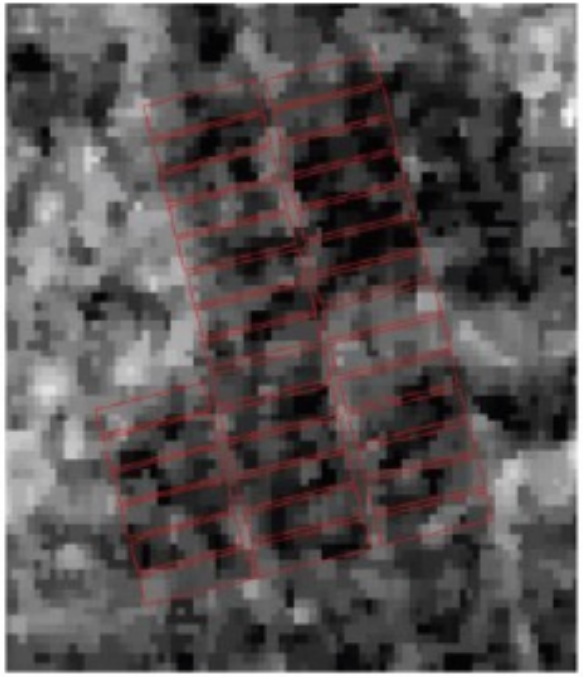
Japan, phase 1



ALOS-2
(24 May, HH)

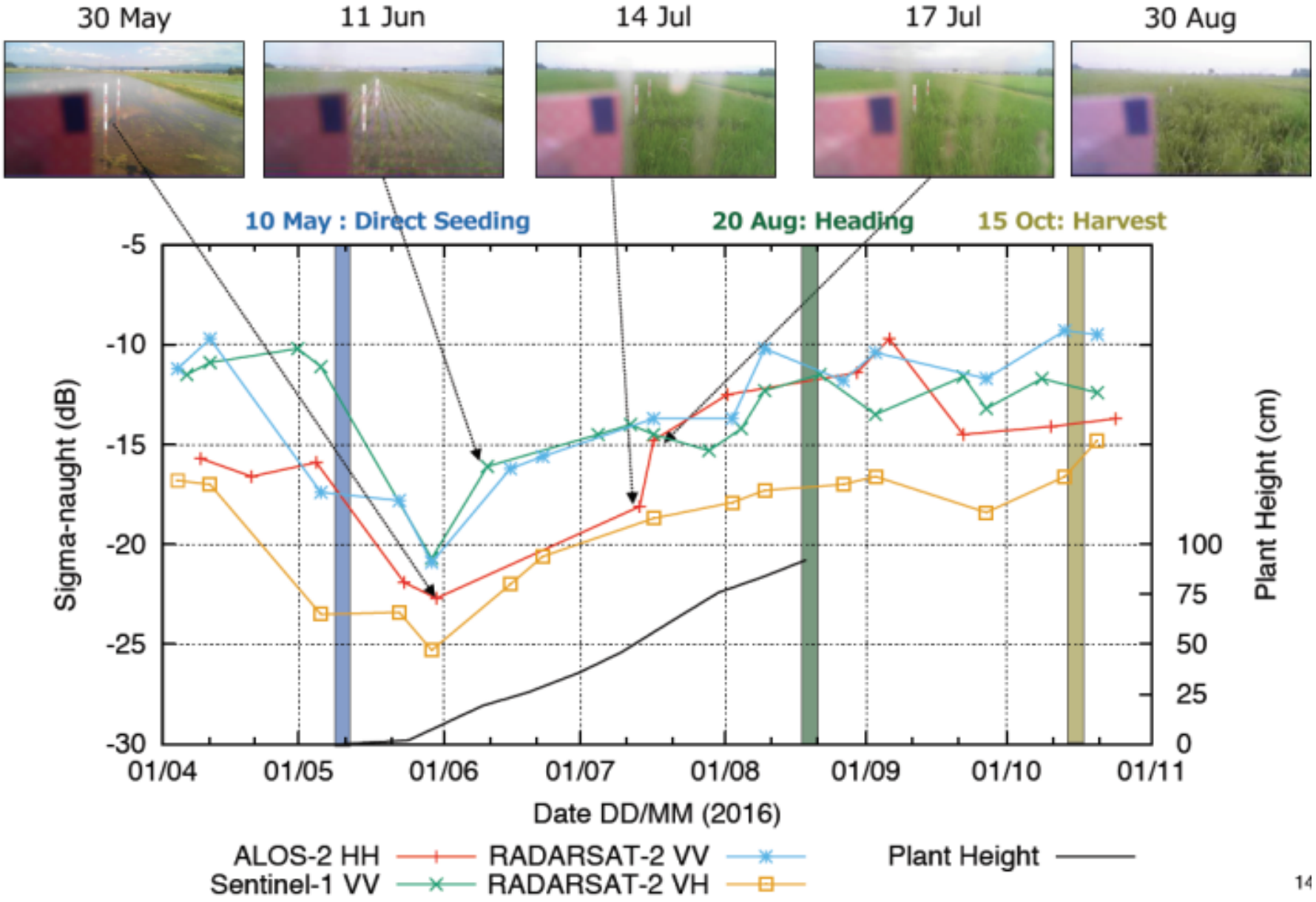


Sentinel-1
(30 May, VV)



RADARSAT-2
(30 May, VV)

Japan, phase 1



Japan, phase 1

- This study investigated the rice plant height estimation by L-band (ALOS-2) and C-band (Sentinel-1, RADARSAT-2) data.
- L-band HH (ALOS-2) showed highest accuracy (10.2 cm), C-band VH (RADARSAT-2) showed the second-highest (11.6 cm).
- Spatial resolution would be also significant factor to estimate plant height because the study area is heterogeneous and small (25x100m).

- Further studies including the integration of optical data, biomass estimation or detailed phenological stage classification are important in terms of a practical use.
- Also, understanding of the physical mechanism between EM wave and rice plant using radiative transfer model would be quite important to consider observing conditions (e.g. frequency, incidence angle etc.) and generalize the rice crop monitoring using SAR.

Implementation status in pilot 4 countries by ADB

Overview

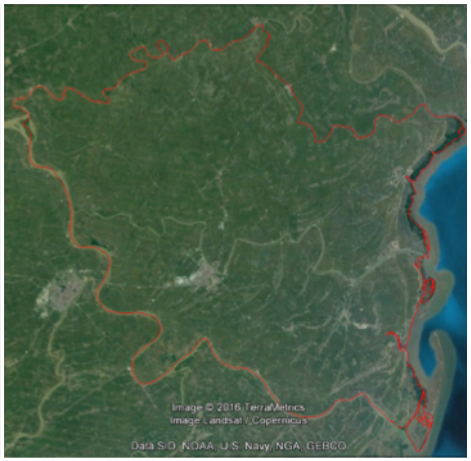
- OUTPUTS

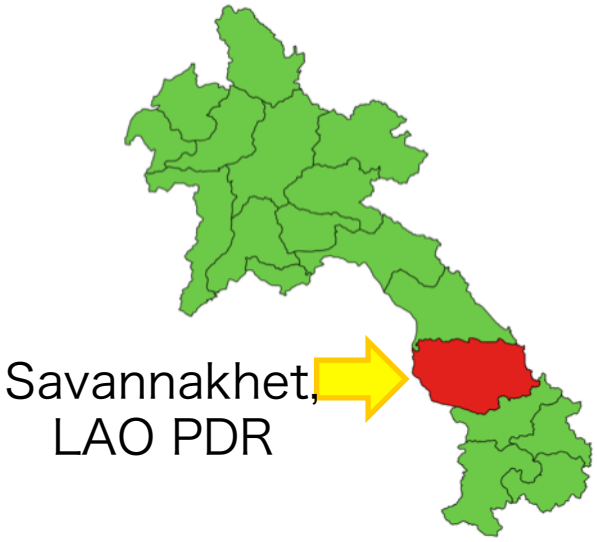
1. Customized INAHOR software on analyzing satellite imagery and similar tools provided to pilot countries.
2. Selected staff in pilot countries are able to use output 1 as inputs into rice crop estimation and forecasting methods.

- Implementation Period: June 2013 to November 2016.
- Executing Agency: Asian Development Bank
- Consulting firm: RESTEC/AIT
- Technical Adviser: Japan Aerospace Exploration Agency (JAXA)

Overview

❖ Pilot Countries & Target area



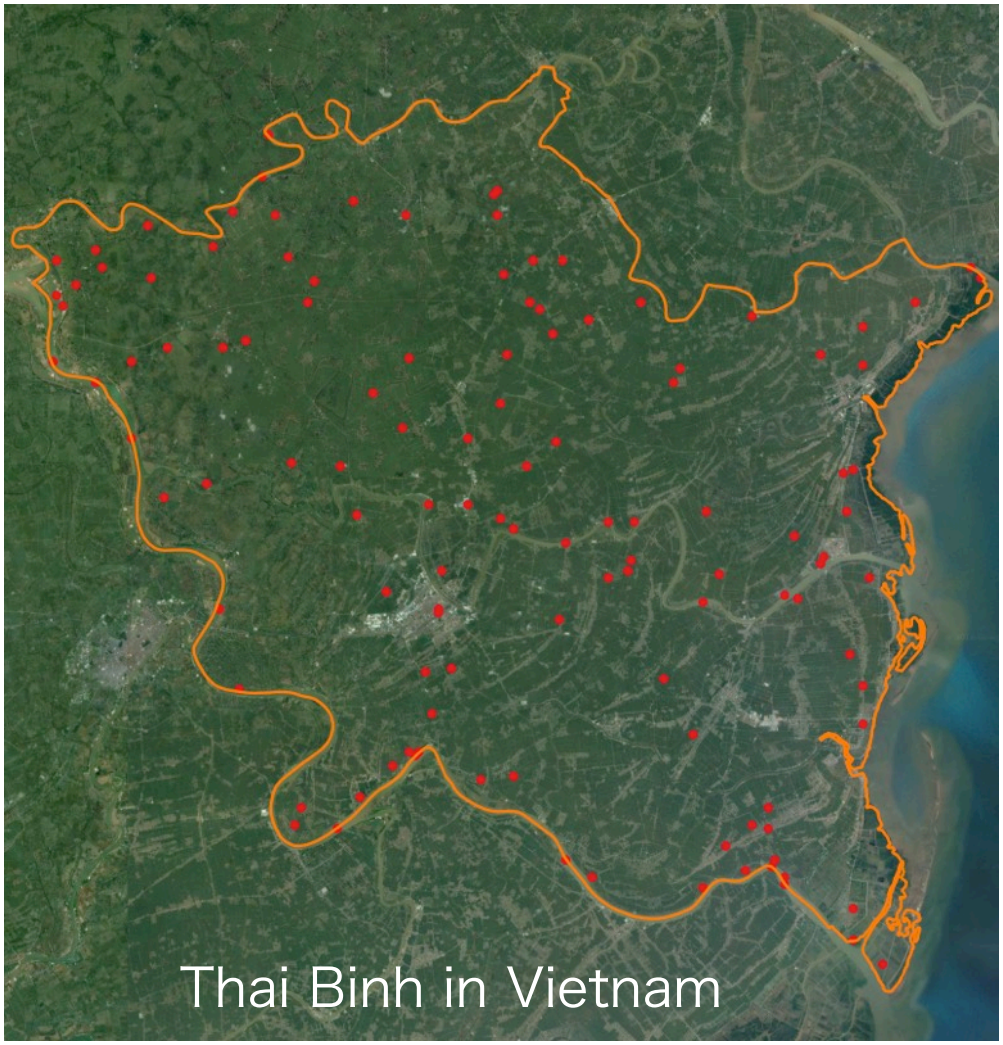


Available data

Target	Cycle	Observation Date	A/D	Path	Operation Mode	Plan O:Planed X:Not_Planed	Observation O:OK X:NoData
Savannakhet_Lao_PDR	25	20150703	D	35	W 2R	0	0
Savannakhet_Lao_PDR	27	20150731	D	35	W 2R	0	0
Savannakhet_Lao_PDR	31	20150925	D	35	W 2R	0	0
Savannakhet_Lao_PDR	32	20151009	D	35	W 2R	X	–
Savannakhet_Lao_PDR	33	20151023	D	35	W 2R	0	0
Savannakhet_Lao_PDR	35	20151204	D	35	W 2R	0	0
Nueve_Ecija_Philippines	22	20150524	D	27	W 2R	0	0
Nueve_Ecija_Philippines	25	20150705	D	27	W 2R	0	X
Nueve_Ecija_Philippines	27	20150802	D	27	W 2R	0	0
Nueve_Ecija_Philippines	31	20150927	D	27	W 2R	0	0
Nueve_Ecija_Philippines	32	20151011	D	27	W 2R	0	X
Nueve_Ecija_Philippines	33	20151025	D	27	W 2R	0	0
AngThong_Thailand	22	20150523	D	38	W 2R	X	–
AngThong_Thailand	25	20150704	D	38	W 2R	0	0
AngThong_Thailand	27	20150801	D	38	W 2R	0	0
AngThong_Thailand	30	20150912	D	38	W 2R	0	X
AngThong_Thailand	33	20151024	D	38	W 2R	0	0
AngThong_Thailand	35	20151205	D	38	W 2R	0	0
ThaiBinh_Vietnam	25	20150624	D	36	W 2R	0	0
ThaiBinh_Vietnam	27	20150722	D	36	W 2R	0	0
ThaiBinh_Vietnam	30	20150902	D	36	W 2R	0	X
ThaiBinh_Vietnam	31	20150916	D	36	W 2R	0	0
ThaiBinh_Vietnam	33	20151014	D	36	W 2R	0	0

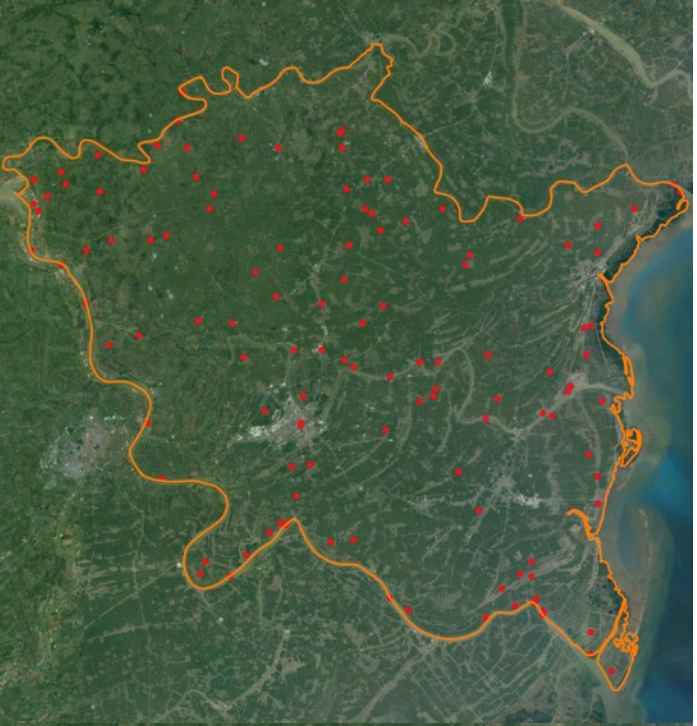
Field survey

- Field survey was conducted for 120 points which were selected randomly from 200m x 200m mesh in the target province.
  In order to
  - Tune the parameters
  - Validate the result



Summary of the tuning

- Parameter tuning was conducted to get the optimized threshold values which to detect inundation area and well-grown area.
- The random sampled field survey data was used for the tuning.
- One field survey data was 200m x 200m mesh.
- 5 points field survey data were used from 120.
- The conditions of the 5 points were 100% rice area and planting stage at the survey in early wet season.
- The estimated results with tuned parameters were validated by comparing with total rice planted area of 120 points .



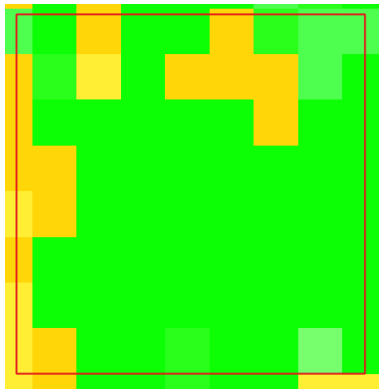
200m

200m

200m x 200m x 30% = 1200m^2

200m x 200m x 100% = 400

Sum of all surveyed mesh rice area = 1,842,



Calculated result for each mesh with INAHOR

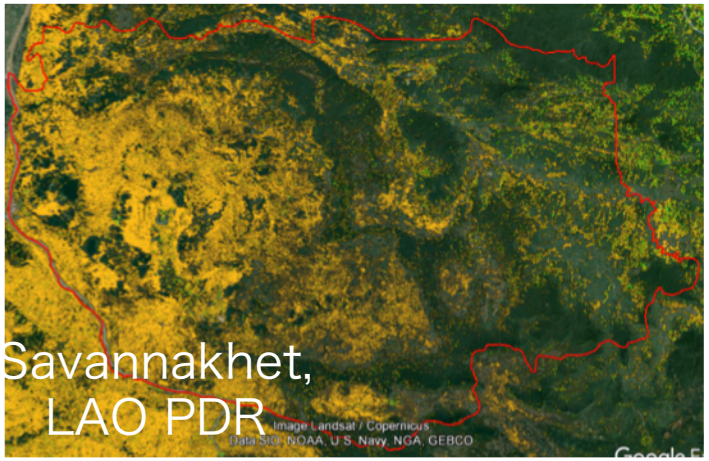
= 1,777,800 m^2

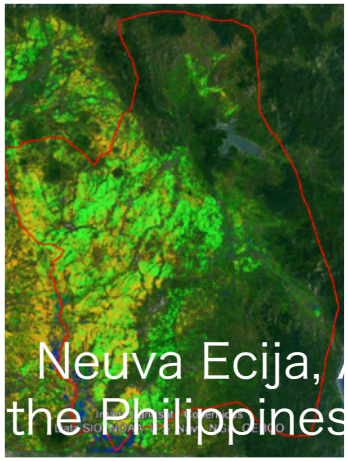
The estimated % = INAHOR / Survey = 96%

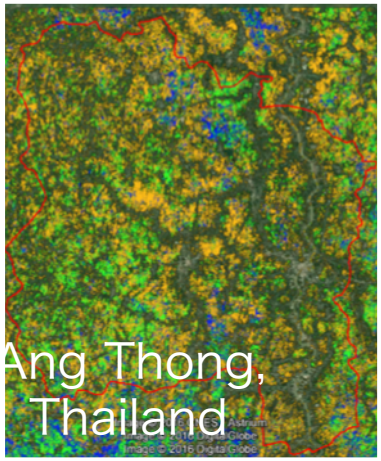
The estimated error is 4%

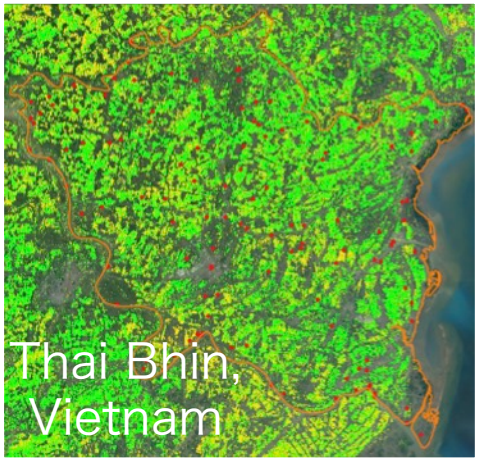
Summary of the tuning

Country	Threshold 1	Threshold 2	Estimated % (error%)
LAO PDR	-18.51	6.13	96% (-4%)
Philippine	-17.86	8.13	93% (-7%)
Thailand	-17.58	3.58	106% (6%)
Vietnam	-17.46	5.99	96% (-4%)









Summary of Validation

Consideration for the reasons of error was conducted, in order to understand the characteristic of the INAHOR result for using it correctly.

- Some rice paddy fields beside a bright target such as a residential building or forest/tree can't be detected sometimes.
- Some smooth surface areas in planting season, such as a pond, river or bare land are sometimes detected as rice paddy, if the smooth surface change to rough in 2nd half of the season.

Summary

Summary

- Asia-RiCE activities are steadily progressing.
- In Indonesia / Vietnam (S), phase 1 was finished. Then phase 2 is ongoing by expanding the target area to main rice production area such as top 10 provinces / Mekong Delta region. The results are validating now under the SAFE Project.
- In Myanmar / Cambodia, phase 1 was started. The results are validating now under the SAFE Project.
- In Japan, a study estimating plant height by using SAR data is ongoing, in order to estimate biomass.
- In ADB project, phase 1 was finished. The results was good. The next project is under consideration between ADB and JAXA.

Thank you for your attention !!