Asia-RiCE Implementation Report 2014

Version 1.0

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Cover + 45 pages

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1. Introduction and Background

1.1. Introduction

The Asia-RiCE initiative has been organised to develop the Asia-Rice Crop Estimation and Monitoring (Asia-RiCE) component for the GEO Global Agricultural Monitoring (GEOGLAM) initiative. GEOGLAM aims to enhance agricultural production estimates through the use of Earth observations, and Asia-RiCE seeks to ensure that the observational requirements for Asian rice crop monitoring are reflected in the GEOGLAM priorities.

1.2. Purpose

This report aims to summarise the activities and achievements of Asia-RiCE to date by providing examples of Technical Demonstration Site (TDS) outputs that have been enabled by the initiative. This document also aims to acknowledge and highlight the impact of contributions from data providers, and the role of the Asia-RiCE initiative in facilitating these inputs.

1.3. Scope

Asia-RiCE is currently working on the development of Phase 1, covering 2013 – 2015 which focuses on demonstration and early feasibility activities. Phase-1A of Asia-RiCE (from 2013) is currently underway and covers the following TDS.

- Indonesia (Subang, West Java Island)
- Thailand (Suphan Buri province)
- Vietnam South (An Giang)

The results detailed in this document will be focused on, though not limited to the above sites, as since 2014 some Phase-1B activities have also started in Japan, Taiwan, etc.

1.4. Main Accomplishments in 2014

Some significant Asia-RiCE accomplishments are listed below. In 2014, Asia-RiCE:

- Worked with CSA/MDA to organise the acquisition and provision of Radarsat-2 data to the TDS
- Prepared a successful JAXA K&C Phase 4 proposal (ALOS/ALOS-2)
- Arranged 42 TerraSAR-X datasets for the TDS free of charge from DLR
- Established a Mekong Delta Sentinel-1A Reference Site, securing early ramp-up phase Sentinel-1A data for researchers
- ISRO collected and delivered RISAT-1 data to the Phase 1A TDS

- The JAXA/RESTEC teams developed the INAHOR and JASMIN tools
- NASA/CEOS SEO developed and tested a cloud computing SAR processing (INAHOR) platform for Indonesia
- Asia-RiCE worked with AFSIS to provide crop condition overview information and outlooks for FAO AMIS through GEOGLAM
- The Asia-RiCE team provided inputs to/assessment of the IRRI MODIS Rice Extent Maps/Calendars, which will replace the current GEOGLAM Crop Monitor rice information

2. Asia-RiCE

2.1. Objectives

Asia-RiCE is the rice crop monitoring component of GEOGLAM, and thus has the aim of strengthening the international community's capacity to produce and disseminate relevant, timely and accurate forecasts of rice production at national, regional and global scales through the use of Earth Observations (EO), which include satellite and ground-based observations.

The goal of Asia-RiCE is to foster the widespread use of EO for 'wall-to-wall', whole country, timely and accurate forecasts of rice production at national, regional, and global scales, as an input to the GEOGLAM Crop Monitor and AMIS Market Monitor.

This is a large task, with many unknowns and undefined procedures. Therefore, Asia-RiCE is leveraging existing agricultural monitoring programs and initiatives at local levels (which serve as the Asia-RiCE Technical Demonstrator Sites (TDS)) to develop, exercise and refine processes – from stakeholder engagement, through resource marshalling and deployment, and on to trial implementation and product generation using SAR (i.e. radar) and other Earth observation data for rice crop monitoring.

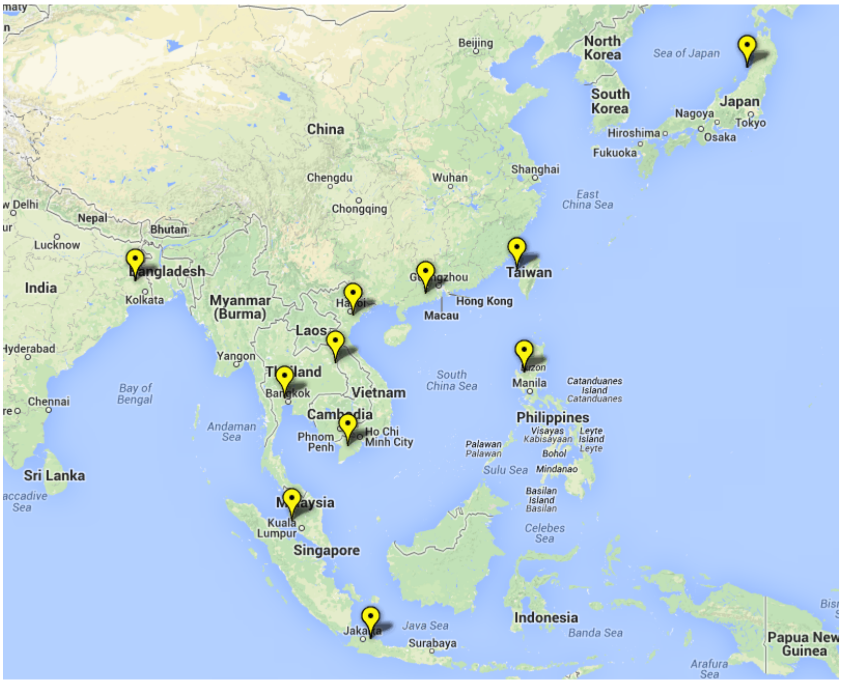


Figure 1 - Asia-RiCE TDS Locations

The TDS are being implemented in phases, and it is envisioned that the scope of each Asia-RiCE TDS will increase over time, with more TDS also being added in the future. As the initial set of TDS develop their methods, gain access to more data, and refine their processes, they will also increase their scope of activities.

Asia-RiCE will define the required outputs from the TDS (i.e. the inputs to GEOGLAM/AMIS), track progress (through annual Implementation Reports), provide a forum for result sharing and reporting (via regular teleconferences and meetings), and also serve as a space agency coordination platform.

2.2. TDS Objectives

As the rice crop monitoring component of GEOGLAM, Asia-RiCE is expected to provide regular outlook forecasts for FAO AMIS, and does so with in-kind contributions of TDS representatives.

To achieve the overall goal of timely and accurate forecasts of rice production, TDS sites will need to develop and refine the generation of a number of key products, including rice crop area and yield estimations.

These target crop and agricultural products are summarised in Table 1. It is expected that these products will be generated with national resources to develop the target products as input to their crop forecasting systems.

Table 1 – Target Products for Asia-RiCE Phase 1

Product	Description
P1: Rice Crop Area Estimates/Maps	Cultivated area (every year) Inventory of agricultural facilities
P2: Crop Calendars/Crop Growth Status	Timing of sowing, planting, growing and harvesting/growing status. Identification of growth stages Planted area progress (every month) per season. Crop growth anomaly
P3: Crop Damage Assessment	Detection of flooding and other disaster impacted area Detection of drought or inundated area Detection of diseased plants, pests and diseased infestation
P4: Agro-meteorological Information Products	Early warning Anomaly detection (drought, extreme temperatures) Crop growth anomaly
P5: Yield Estimation and Forecasting	Empirical-statistical model estimate Crop-growth simulation model estimates

Note: Phase 1A only covers rice area statistics, maps, and yield estimates. The other products will be covered in Phase 1B/2 . Products such as crop growth anomaly require studies of historical remotely sensed data, and others through indices will be implemented in a future phase. In addition, we expect to produce rice crop area, crop calendar, and crop damage assessments using SAR data.

CEOS agencies are being asked to support Asia-RiCE, through GEOGLAM and JECAM, by providing satellite data. This data is essential to develop the demonstration products outlined, and the provision of this data comes with the expectation that the teams for each of the technical demonstrator sites will generate rice crop products.

Further description of these products and their associated EO data requirements can be found in the *Asia-RiCE GEOGLAM Phase 1 Space Data Requirements* document.

2.3. TDS Satellite Data Utilisation

Each of the Asia-RiCE TDS have access to different space data, either arranged through Asia-RiCE or otherwise due to heritage with a particular EO source. The following table summarises the space data currently in use by each TDS, and also highlights future expected/desired data sources.

Table 2 – Satellite data in use by each TDS (F = Future Plans)

TDS Country	Radarsat-2	TRMM	Terra/Aqua (MODIS)	Landsat-7	Landsat-8	RapidEye	KOMPSAT-2/3	Cosmo-SkyMed	Sentinel-1A	GCOM-W	ALOS	ALOS-2	RISAT-1	Envisat ASAR	TerraSAR-X	SPOT (unspecified)	GPM	MTSAT-1R/2	Himawari-8
Indonesia	✔	✔	✔	✔	✔					✔	✔	F	F		F		✔	✔	
Thailand	✔	✔	✔							✔	✔	F	✔				✔		
Vietnam (N)	✔	✔								✔		F	F				✔		
Vietnam (S)	✔	✔	✔					✔	F	✔	✔	F	F	✔	✔		✔		
Lao P.D.R.	F		F									F							
China																			
India												F							
Japan	✔	✔	✔	✔	✔				F	✔	✔	F	F		F		✔	✔	F
Malaysia	✔											F							
Taiwan	✔		✔	✔	✔							F				✔			
Philippines	✔	✔	✔						F	✔		F			✔		✔		
South Korea	✔		✔	✔	✔	✔	✔			✔		F					✔		

2.4. Asia-RiCE Data Source Organisation and Progress

Radarsat-2

Asia-RiCE has facilitated the acquisition and provision of Radarsat-2 data to its members through a joint SOAR-JECAM proposal. The goal of the RADARSAT-2 SOAR-JECAM is to develop and demonstrate techniques where RADARSAT-2, either alone or integrated with other data sources, contributes useful information about crop area, condition monitoring and yield estimation, over a wide range of geographies and cropping systems. This arrangement was made possible by the strong link between Asia-RiCE, GEOGLAM, and the Committee on Earth Observation Satellites (CEOS) and the generous support of the Canadian Space Agency (CSA) and MacDonald, Dettwiler and Associates (MDA).

ALOS-2

The extension of the Kyoto & Carbon Initiative (KC-4) was approved by JAXA management on October 17th, for a duration of 4.5 years, and the proposal prepared by Asia-RiCE was one of the 32 selected for K&C Phase 4. The acceptance of this proposal will secure (preferably monthly or better) ALOS-2 PALSAR-2 ScanSAR (HH+HV) data and K & C research products from PALSAR-S ScanSAR and FBD over many Phase 1A/1B sites, and will play a major role in the success of Phase 1B, especially in producing wall-to-wall national estimates of rice crop area and production estimates at the provincial level. Additionally, the proposal also included a request for access to historical ALOS PALSAR FBD (HH+HV) mosaic products (2007, 2008, 2009, 2010) and ALOS-2 PALSAR-2 fine mode (10m dual and 6m full polarization) for selected TDS, for the development and verification of yield estimation algorithms and other research.

TerraSAR-X

Asia-RiCE successfully coordinated the acquisition of 42 TerraSAR-X datasets free of charge, thanks to the TerraSAR-X Science Service System offered by DLR. The 42 acquisitions will be distributed amongst the three sites in Japan, Indonesia, and South Vietnam. Several acquisition requests have been made for 2014, however due to commercial prioritization, it is uncertain whether any scenes will be acquired in 2014.

Sentinel-1A

Through GEOGLAM and CEOS, Asia-RiCE has been able to negotiate Sentinel-1A commissioning and ramp-up phase coverage for a joint Asia-RiCE/IRRI/RIICE/NCU reference site in the Mekong Delta. Three areas with existing rice crop monitoring projects are covered by the site: An Giang TDS (JAXA, Asia-RiCE), Soc Trang (IRRI/RIICE) and Cantho (National Central University, Taiwan). ESA will acquire, on a best effort basis, Interferometric Wide Swath 250km, VV/VH polarised data, with a preference on ascending passes.

Data has been received, albeit slightly delayed by Sentinel-1A's initial orbital positioning issues, and it has been analysed by the south Vietnamese Asia-RiCE team and CESBIO. Asia-RiCE, IRRI, and NCU are coordinating on how to collect and share consistent ground data between the three projects, and are also working on defining the major outputs (e.g. rice maps, biological parameters, phenological data) as well as working to reach a consensus on sampling methodologies.

Results have been shared at the Sentinel-1A preliminary assessment meeting, and will be shared with the Asia-RiCE team as soon as possible.

In the near future it is planned that the scope of Sentinel-1A ramp-up coverage will be expanded to cover a number of countries/sites in South East Asia every 12 days (each repeat cycle). Asia-RiCE has requested that in this scenario, the focus should be the same as the priority countries of Asia-RiCE Phase 1A and IRRI (Indonesia, Thailand, Vietnam, and the Philippines).

CESBIO have also prepared an ESA DUE Innovator III proposal on behalf of Asia-RiCE. The ESA DUE Innovator III program seeks to respond to the R&D agendas of major international initiatives and perform the necessary preparatory activities for a large-scale exploitation of the most innovative aspects of ESA's Sentinel missions. The Asia-RiCE proposal focuses on the development of methodologies for the operational use of Sentinel-1 for rice crop monitoring. The results of ESA's proposal evaluation will be released in late 2014.

RISAT-1

ISRO have generously offered to acquire data over the Phase 1A TDS free of charge, in exchange for ground truth data. Acquisitions have been made and partially delivered for Indonesia, Thailand, and Vietnam North/South.

TRMM, GPM, MTSAT-2, GCOM-W

JAXA have provide agro met information derived from those satellites and MODISdata for Asia rice crop outlook activity in cooperation with NASA through JAXA's information system named "JASMIN". Himawari will be used for rainfall.

2.5. Cloud Computing System and INAHOR

RESTEC provides the technical and administrative support for JAXA's lead role in Asia-RiCE. In 2009 and 2010, a system was developed for the Ministry of Agriculture, Forestry, and Fisheries (MAFF) to estimate rice crop acreage using GIS and space-based remote sensing data. During 2011 and 2012, the JAXA-GISTDA Rice Crop workgroup in collaboration with RESTEC developed software to estimate rice crop acreage and production using space-based Synthetic Aperture Radar (SAR) from the ALOS and THEOS series of satellites.

The software, named INAHOR (INternational Asian Harvest mOnitoring system for Rice) will be applied to Vietnam and Indonesia under a Space Application for

Environment (SAFE) prototyping project of the Asia Pacific Regional Space Agency Forum (APRSAF). The result will also be also useful for Asia-RiCE.

The CEOS SEO (NASA) is working to provide cloud computing storage and processing capability using their Space Data Management System (SDMS) to allow JAXA to test INAHOR on Radarsat-2 data over Indonesia to demonstrate enhanced performance over using local JAXA systems for internet download and processing.

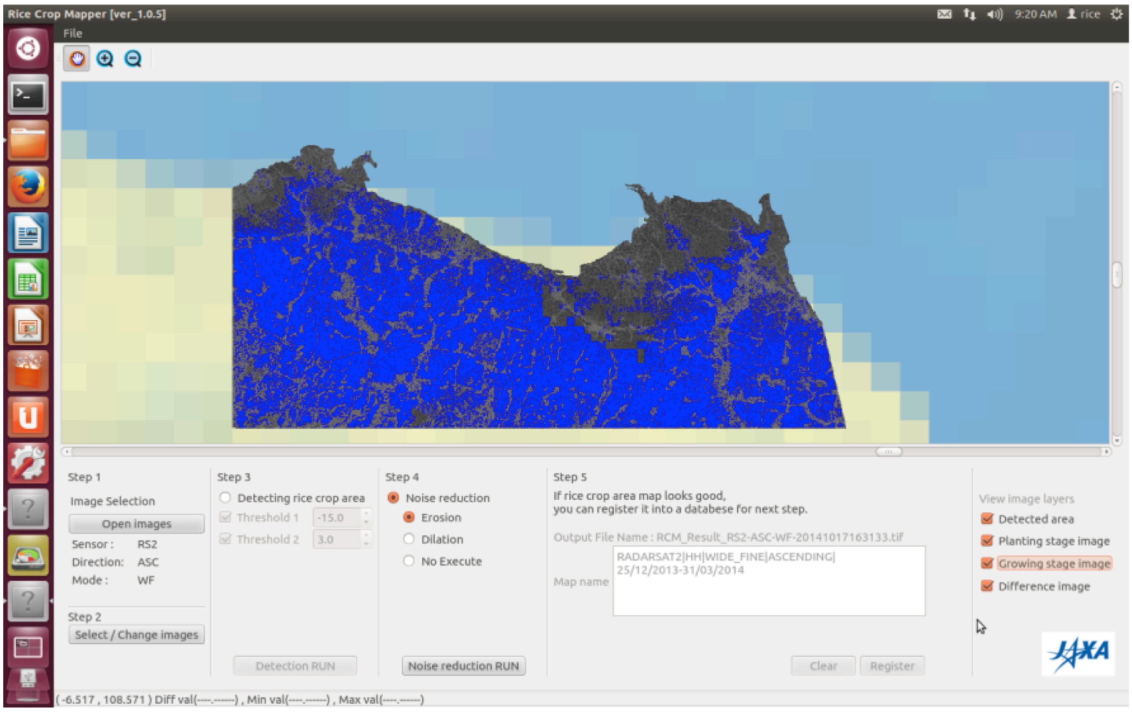


Figure 2 – INAHOR Software, demonstrating rice area detection using Radarsat-2 SAR data

2.6. JASMIN Agro-meteorological Tool

The JASMIN agro-meteorological information tool has been developed by RESTEC under contract to JAXA, to assist ASEAN Food Security Information System (AFSIS) and target country agricultural statistics experts with the FAO AMIS outlooks for Asia-RiCE by providing satellite derived agro-meteorological information. Six parameters are updated twice a month:

Table 3 – JASMIN Parameters

Parameters	Interval	Spatial Resolution	Data Period (Anomaly calc.)	Satellite Data Source
Precipitation	Cumulative (15-days)	10 km	2002- (2002-2012)	GSMaP (GCOM-W1, TRMM etc)
Drought Index	15th / 31[30]th Day of month	10 km	2006- (2007-2012)	GSMaP, MTSAT
Soil Moisture	15-days average	50 km	2009- (2002-2012)	AMSR-E, WindSat, AMSR2
Solar Radiation	15-days average	5 km	2002- (2007-2012)	MODIS
Land Surface Temperature	15-days average	5 km	2002- (2002-2012)	MODIS
Vegetation Index	15-days average	5 km	2002- (2009-2012)	MODIS

The JASMIN tool is able to generate two types of product for each parameter – current condition, and anomaly, which is the deviation from past years averages. JASMIN can generate either a map of the whole country or time series graphs at a number of pre-defined locations.

JAXA and RESTEC are now developing a flood parameter for JASMIN due to the frequent mention of the impact of floods in the outlooks. In the future, JASMIN will be expanded to support FAO AMIS outlook reporting for more ASEAN countries in cooperation with AFSIS.

2.7. FAO AMIS Outlook Reporting

Asia-RiCE has been working with the GEOGLAM Task Team since October 2013 to support FAO AMIS by providing crop condition overview information and outlooks based on agro-meteorological information. Outlooks are performed in cooperation with AFSIS, and currently cover the three Phase 1A countries – Indonesia, Thailand and Vietnam. It is planned that the outlooks will be expanded to include the Philippines from November 2014.

Outlooks are produced in collaboration with AFSIS. The Asia-RiCE team reviews the outlooks and satellite agro-meteorological data before submitting the reports to GEOGLAM. GEOGLAM then compiles the information into the Crop Monitor for the FAO AMIS Market Monitor. Shoji Kimura (AFSIS expert) has developed a Rice Growing Outlook Methodology to assist agricultural experts in understanding how to use agro-met information for their outlook activities.

3. Technical Demonstration Site Achievements and Progress

3.1. Technical Demonstrator Site Status Overview

The following table provides a brief summary of the achievements and capabilities of each Asia-RiCE TDS, with the aim of indicating where future efforts might be directed.

Table 4 – Summary of Asia-RiCE TDS Capabilities and Achievements (F = Future Plans, IP = In Progress)

Country	P1: Rice Crop Area Estimates & Maps	P2: Crop Calendars/Crop Growth Status	P3: Crop Damage Assessment	P4: Agro-met Information Products	P5: Yield Estimation & Forecasting
Indonesia	IP	IP	F	IP	F
Thailand				IP	
Vietnam (N)				IP	
Vietnam (S)	IP	F		IP	IP
Lao P.D.R.					
China					
India					
Japan	IP	IP	✔ / IP	✔	IP
Malaysia	F				
Taiwan	IP	F			F
Philippines	IP	IP		F	✔
South Korea	✔		✔		✔

3.2. Indonesia – Subang, West Java Island

Organisation

National Institute of Aeronautics and Space of Indonesia (LAPAN) are the technical implementer and optical data provider. LAPAN are also receiving and disseminating Radarsat-2 data to the other Indonesian Co-I's. LAPAN is developing a rice growth model based on Radarsat-2 data, monitoring paddy growth stages using MODIS (every 8 days), and identifying drought/flood in paddy fields using MODIS and TRMM data.

The Indonesian Center for Agricultural Land Resources Research and Development (ICALRD), Indonesian Agency of Agricultural Research and Development (IAARD), Ministry of Agriculture (MoA) of Republic of Indonesia support the production of information including paddy planted area and harvested area for the National Bureau of Statistics of Indonesia (BPS). Specifically, the MOA are implementing the Radarsat-2 growth model and producing rice area maps.

Bogor Agricultural Institute (IPB) is acting as a technical supporter.

Field statistical data is provided by Badan Pusat Statistik (BPS, the National Bureau of Statistics of Indonesia, sub-directorate of food crops).

Crop acreage, production and other agricultural information is published by the National Bureau of Statistics of Indonesia and are obtained either by traditional overall reporting (summary of several administrative levels) or directory sampling based on classical statistics (ubinan).

Basic objectives

To develop and use the rice crop yield estimation model to provide comprehensive and accurate information to the BPS and Ministry of Agriculture.

The Indonesian team is currently working on their rice growth status determination methods, and next year they are planning to produce yield estimates/forecasts. In the near future they are targeting the development of crop damage assessments & agro-meteorological information products

In terms of the Asia-RiCE target products, the near future plans of the Indonesian team are summarised in the following table:

Table 5 – Near-future plans of the Indonesian team

Product	Near-future Plans
Rice Crop Area Estimates & Maps	Compile the rice crop area map.
Crop Calendars/Crop Growth Status:	Verify the Radarsat-2 crop growth model.
Crop Damage Assessment	LAPAN currently has agromet information products such as drought & flood monitoring in paddy fields based on MODIS data.
Agro-met Information Products	Move to monthly predictions of drought & flood in paddy fields based on MODIS & TRMM data
Yield Estimation & Forecasting	Develop the yield estimation model

Satellite data

The LAPAN ground station provides them with direct downlink access to MODIS and Landat-8 data. MODIS is used to monitor paddy growth stages at 8 day intervals. TRMM data is also being used in conjunction with MODIS to identify drought/flood in paddy fields.

LAPAN are currently receiving Radarsat-2 data, provided by CSA/MDA via the SOAR-JECAM framework to develop a rice growth model using JAXA systems for internet download and processing. CSA has initiated a data acquisition plan to acquire 35 scenes over Indonesia from Aug-2013 through Oct-2014 (with 27 complete and received as of writing), and the details are as follows:

Table 6 – Radarsat-2 acquisition details for Indonesia

Beam	Pass	Product type	Format	Incidence angle (near range)	Incidence angle (far range)
Wide Fine (F0W2) VV VH	Descending	SGF	GeoTIFF	30.71	39.54
Wide Fine (F0W2) VV VH	Ascending	SGF	GeoTIFF	30.68	39.52

Descending	Ascending
23-Aug-13	–
3-Nov-13	–
27-Nov-13	1-Dec-13
21-Dec-13	25-Dec-13
14-Jan-14	18-Jan-14
7-Feb-14	11-Feb-14
27-Mar-14	31-Mar-14
20-Apr-14	24-Apr-14
14-May-14	18-May-14
7-Jun-14	11-Jun-14
1-Jul-14	27-Jun-14

Indonesia, in collaboration with JAXA, are one of the initial pilots of CEOS SEO Space Data Management System (SDMS). The SEO will provide cloud computing storage and processing capability to allow JAXA to test their SAR processing tools (INAHOR) on Radarsat-2 data over Indonesia to demonstrate enhanced performance over using local. The Indonesian Asia-RiCE SDMS will specifically use Radarsat-2, Wide-Fine (FOW2), Dual-polarization images (35 total, ~210 GB).

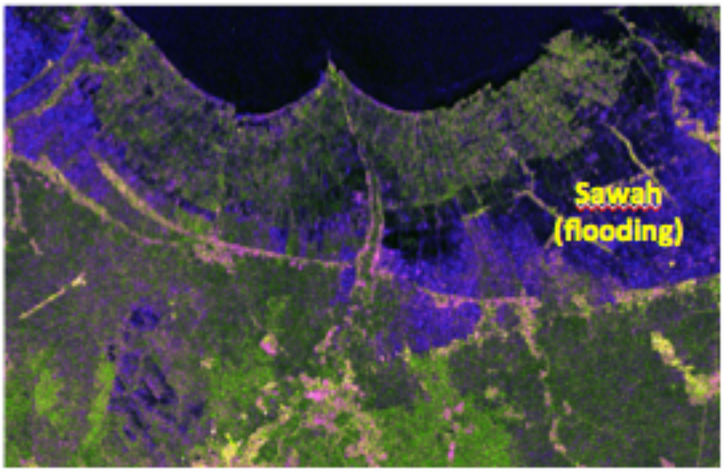
Ground data collection

Ground data is also collected at the site (most recently in August 2014), including details of planting dates, harvest dates (from archive data), and photographs.

Several field visits and ground data collections have been carried out to coincide with the planned Radarsat-2 acquisitions. 2.5m × 2.5m sampling was used for the ground data collection and the parameters measured included plant density, surface water depth, and plant yield.

2014 Results

The Indonesian team has received at 27 Radarsat-2 data from CSA/MDA over the August 2013 to September 2014 period. They performed pre-processing on the data such as geometric & topographic corrections, data filtering, and also converted the digital values to backscattering values. The effect of polarisation ratio has also been investigated, as shown in the following figure.



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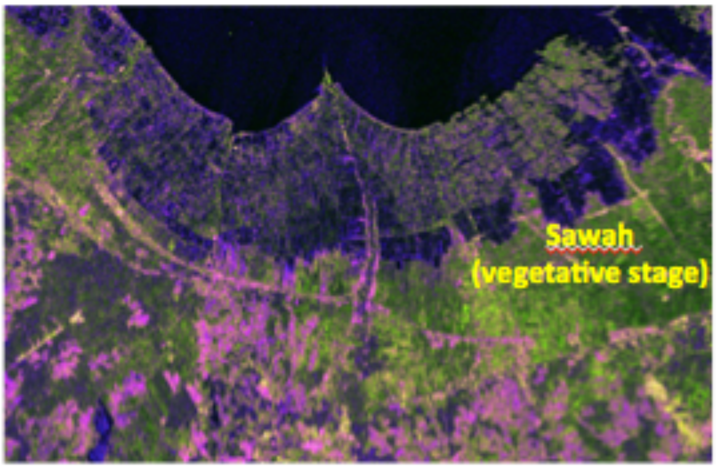

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Figure 3 – Increasing backscatter with growth stage, Radarsat-2, Tanggal, 03 November 2013, Red : VV, Green : VH, Blue : VV/VH

They have also analysed and extracted dB values, to use with ground data information to generate the crop growth model. A paper on the Radarsat-2 based crop growth model is currently being finalised and will be published shortly. In the future they will also develop a yield model which will be facilitated by the Radarsat-2 data. The following image demonstrates rice phenological stage classification using Radarsat-2 data (VH/VV) (29th July 2014, Subang area, West Java).

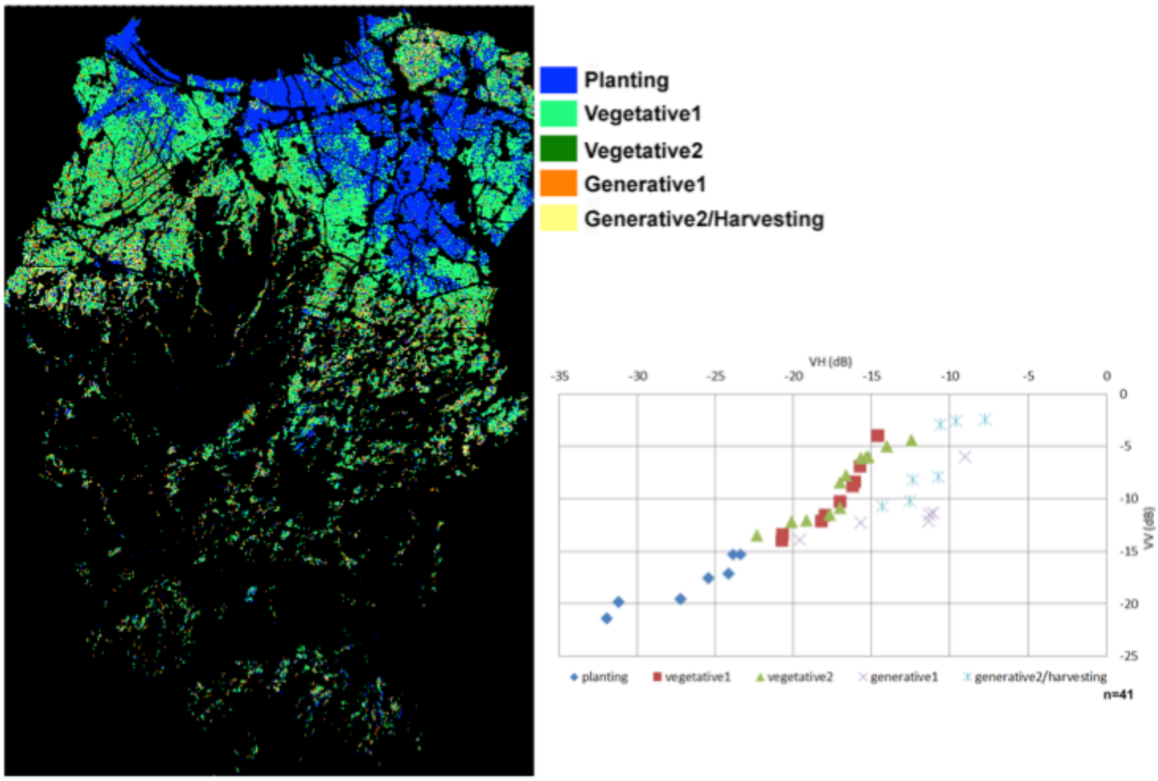


Figure 4 - Rice phenological stage classification using Radarsat-2 data (VH/VV) (29th July 2014, Subang area, West Java).

IAARD is planning to send 6 staff for basic SAR training at MDA in Canada in November 2014. The staff are from ICALRD, Paddy Research Institute (BB Padi), Indonesian Agroklimate and Hidrology Research Institute (IAHRI), and also the Indonesian Agricultural Wetland Research Institute (IAWRI). It is hoped that the training will greatly improve their ability to process SAR data for crop monitoring.

Data processing using INAHOR on the NASA/JAXA cloud computing platform has been tested and used to analyze the planted areas of paddy's, however the process was found to be quite slow because the full scene data of Subang is very large and the transfer method is not currently optimised for the low internet bandwidth. The NASA SEO is currently investigating the issue and working on a solution. Another issue is that the analysis of growing stages and crop damage rely on other software, such as ENVI and ErMapper, and unfortunately the GeoTiff data on the cloud computing interface (running under Linux) cannot currently be easily transferred to a Windows system (to be used with ENVI and ErMapper).

A summary of the INAHOR software training (data acquired in 2013) and an accuracy assessment will be prepared for SAFE reporting. The report will also include details and results related to the cloud computing platform, pending resolution of the bandwidth issues.

3.3. Thailand – Suphan Buri Province

Organisation: GISTDA (TBD)

Links to Existing Agricultural Authorities: Office of Agricultural Economics (OAE), RD

Basic objectives

Summary of Expected Outputs and Benefits: Rice crop area and yield estimates

Satellite data currently in use

Satellite/ Instrument	Spatial Resolution	Revisit Frequency	Product Delivery Format
RADARSAT RADARSAT-2	Wide Fine mode	Monthly	VV&VH SLC data
RISAT-1	50m (CRS)	TBD	TBD
ALOS	100m (ScanSAR)	Monthly	TBD
MODIS	TBD	TBD	TBD

2014 Results

The Thai team are using SAR data from Radarsat-2 to detect paddy fields by comparing images from the transplanting season and well-grown seasons, and then performing post-processing to determine rice crop acreage and yield estimates. There are two crop seasons per year in Suphan Buri. They have reported that at their validation study sites they have achieved area accuracies of 98.58%, and 81.87% production accuracy.

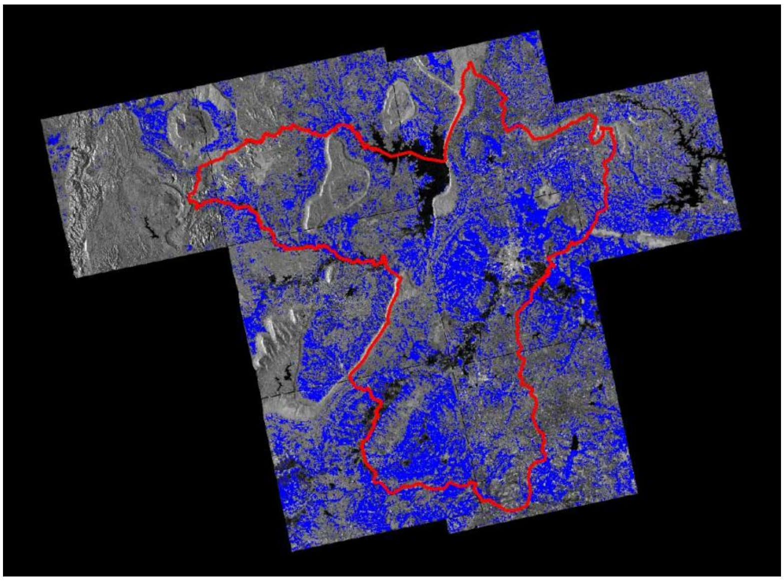


Figure 5 - Rice crop acreage estimation using SAR imagery

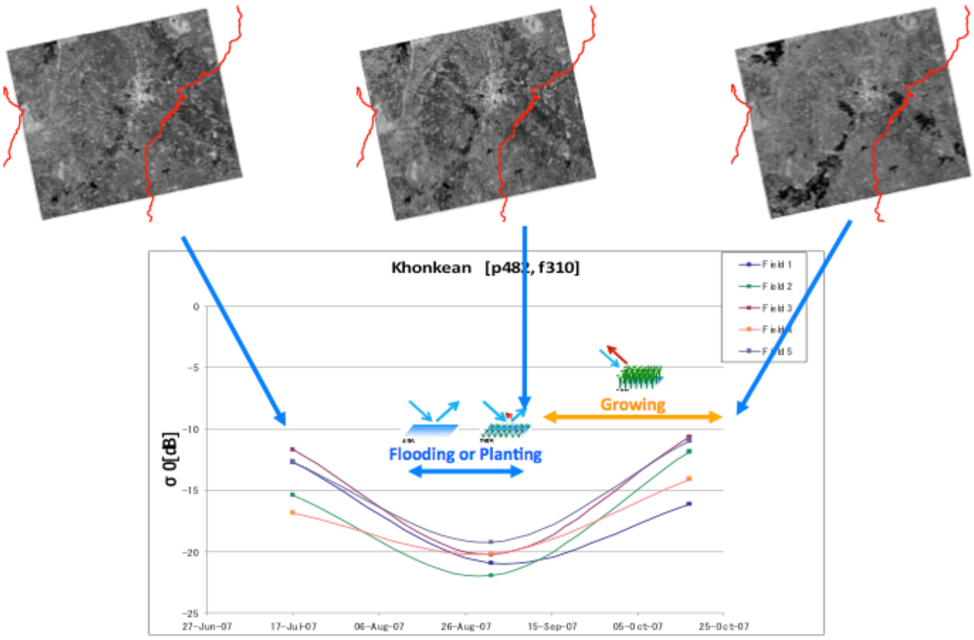


Figure 6 - Rice crop acreage estimation using SAR images. The images exhibit the characteristic backscatter variation over the growth cycle.

The Thai team uses 24 of the same field servers (FS) as the Japanese team, which take 2 images of the crops daily, along with weather condition measurements every five minutes (temperature, humidity, soil moisture, light intensity, rain volume, wind speed, and direction).

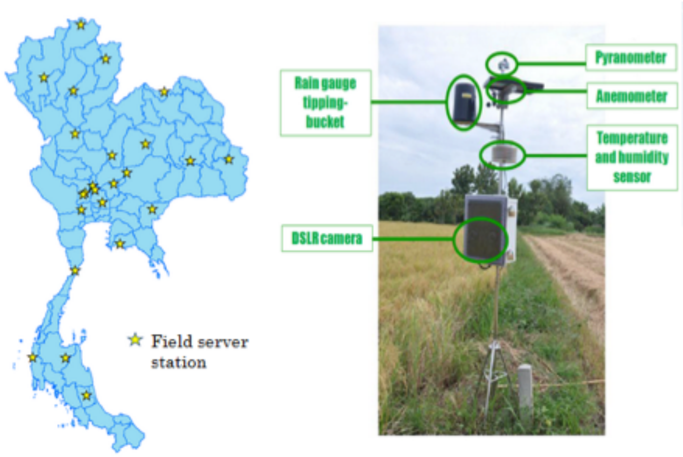
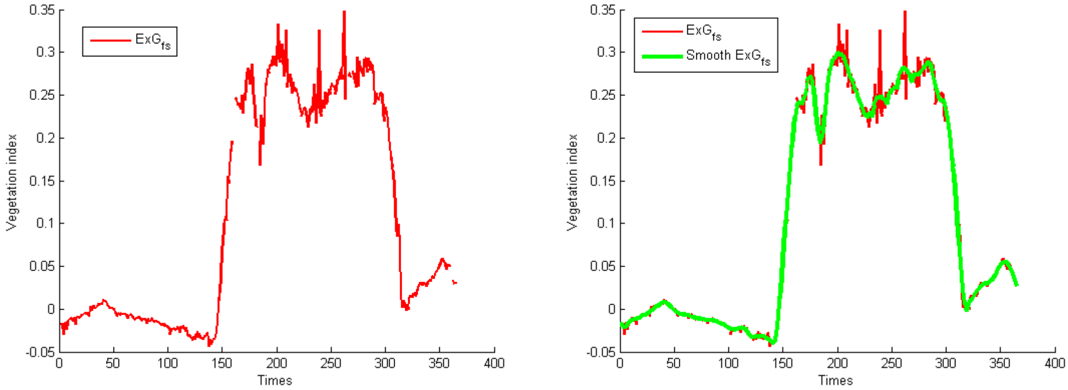


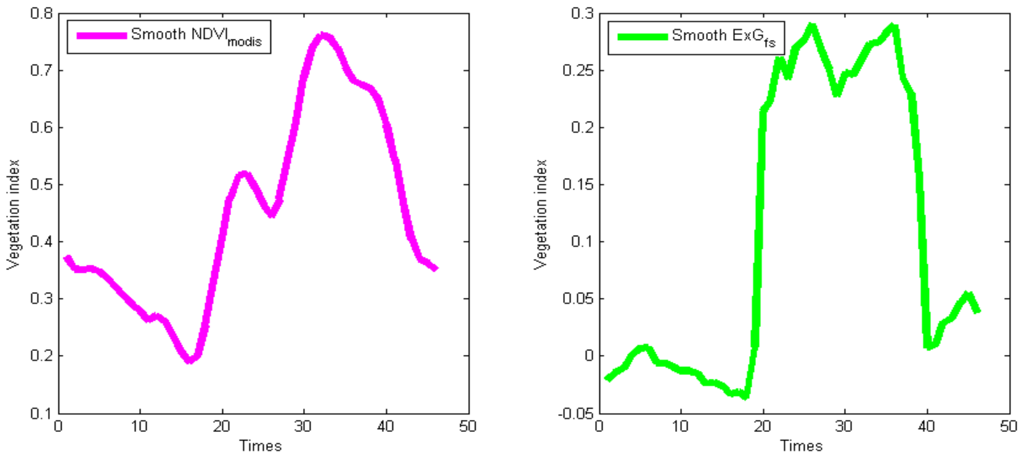
Figure 7 - Field data collection server

Ground observation images (RGB) are obtained from the FS, which provides daily images at 10:00 a.m local time. Determination of vegetation index relies on ExG indexes. To obtain the phenology from FS images as shown in figure 3, the computation steps are as follows 1) Determine the paddy region on FS image (paddy segmentation) 2) Compute the vegetation index from the daily image (the ExG index is used for the FS images) 3) Fill in the missing points (interpolation) and smooth the phenology using a Savitzky-Golay filter.



(a) (b)

Figure 8 - Phenology from FS (daily images) based on ExG: a) Phenology b) Smooth phenology.



(a) (b)

Fig.8 Comparison of the phenology curves between (a) MODIS and (b) FS images.

MODIS provides phenology information based on 8-day composite images while the FS allows for daily phenology information. To compare the results from MODIS and the FS, the DOYs extracted from MODIS images are used as the temporal index reference. As shown in figure 4, the two phenology curves derived from MODIS and FS images are compared for the corresponding DOYs. It should be noted that the FS phenology is re-sampled and mapped to the MODIS phenology.

In the future they are aiming to test their methodology using data from another 9 DCS, calculate the integral without requiring a full crop cycle, and conduct a test to compare the accuracy of using vegetation index from optical satellite images (R, G, B, NIR) and from the field servers.

3.4. Vietnam – Thai Binh (North)

Organisation

The Space Technology Institute (STI) under Vietnam Academy of Science and Technology (VAST) is the implementing agency of the Asia-RiCE TDS in North Vietnam (Thai Binh province).

The National Institute of Agriculture Planning and Projection generates rice production statistics, monthly reports on rice planting, participate in methodology development and will apply the result of the Asia-RiCE work.

The Local Department of Agriculture and Rural Development provides information on rice farming habits, rice planting status, participate in field work and apply the results of the Asia-RiCE work.

Basic objectives

A proposal has been submitted to VAST asking for funding for a project on rice monitoring using radar data from multiple satellites. The main objective is to develop the methodology to process and integrate radar images from multiple satellites (acquired at different frequencies, with different polarization, viewing angle and resolution) for rice monitoring as well as to determine the optimal set of images for this purpose (in terms of acquisition time, frequency band, polarization, looking angle etc.).

Satellite data

VAST has since agreed to fund the project, however the proposal suggested that the satellite images would be acquired through Asia-RiCE and unfortunately no images have been received to date. A SOAR-JECAM proposal has been submitted to CSA/MDA but they are yet to receive any data. VAST has postponed the funding until 2015, when it is hoped that the data should be available.

3.5. Vietnam – An Giang (South)

Organisation

Ho Chi Minh City Institute of Resources Geography (HCMIRG), Vietnam Southern Satellite Technology Application Center (STAC-VNSC), and Vietnam Academy of Science and Technology (VAST)

- Surveying, measuring, and collecting data from the field, radar imagery, maps, etc.
- Processing and analysing data.
- Establishing tools and models.
- Checking and assessing results.

An Giang University (AGU)

- Providing statistical field data.
- Assisting in collect field data.

An Giang Agriculture and Rural Development Department (AGDARD)

- Providing statistical data

Centre d'Etudes Spatiales de la BIOsphère (CESBIO), France

- Providing technical advice for satellite data processing and field survey.

Japan Aerospace Exploration Agency (JAXA)

- Providing satellite data and technical support for data processing.

Study area

The study region is located in An Giang province, and a selection of sampling sites are used in order to capture the diversity in rice cropping systems (two or three crops per year) and in cultural practices. For each site, measurements are performed on several fields.

Basic objectives

The South Vietnamese Asia-RiCE team is currently monitoring rice cropping areas and growth, and plan to begin estimating rice yield and production in 2015. In the near future they are aiming to establish a monitoring system for rice crops and crop growth status, as well as to produce yield and production estimates using radar and optical data.

The Vietnamese team's APRSAF SAFE prototyping activities have continued, with work focused on assessing their model for mapping rice area and yield/production with SAR data.

In terms of the Asia-RiCE target products, the progress of the South Vietnamese team is summarised in the following table.

Table 7- Target product progress of the South Vietnamese team

Product	Progress
Rice Crop Area Estimates & Maps	Sharing any progress with colleagues during seminars, workshops, etc. They are currently using COSMO-SkyMed and RADARSAT-2 data for mapping rice area. In the near future they also want to use other SAR data from satellites such as ALOS-2, RISAT-1.
Crop Calendars/Crop Growth Status:	In the near future the team will implement a crop growth status monitor and develop crop calendars.
Crop Damage Assessment	
Agro-met Information Products	
Yield Estimation & Forecasting	Currently, COSMO-SkyMed and RADARSAT-2 imagery is used for yield estimation. The team will continue to use this data and others to test their models.

2014 Satellite Data

Satellite/Sensor	Time period	Scenes number	Beam modes	Incidence angles (deg)	Spatial resolution (m)	Processing level	Data supplier
RADARSAT-2	2013-2014	26 (30 planned)	Wide Fine (F0W2)	30.613-39.488	5		MDA
COSMO-SkyMed Stripmap	2013-2014	13	PingPong - Right	45.746-47.057	10	L1B (DGM_B)	CESBIO

AW 2013 WS 2014 and SA 2014 rice crop

Dates of RADARSAT-2 data used (Descending): 13 dates

No.	Sensor	Date of required	Pass	Season
1	RADARSAT-2	2013-Aug-29	DES	AW2013
2	RADARSAT-2	2013-Sep-22	DES	
3	RADARSAT-2	2013-Oct-16	DES	
4	RADARSAT-2	2013-Nov-09	DES	
5	RADARSAT-2	2013-Dec-03	DES	WS2014
6	RADARSAT-2	2013-Dec-27	DES	
7	RADARSAT-2	2014-Jan-20	DES	
8	RADARSAT-2	2014-Feb-13	DES	
9	RADARSAT-2	2014-Apr-26	DES	
10	RADARSAT-2	2014-May-20	DES	SA2014
11	RADARSAT-2	2014-Jun-13	DES	
12	RADARSAT-2	2014-Jul-07	DES	
13	RADARSAT-2	2014-Jul-31	DES	

The following table is a summary of the data used to date, and the temporal requirements for producing rice maps and yield estimates.

Table 8 - *South Vietnam TDS satellite data use to date*

Data type	Time	Polari-zation	Rice mapping		Yield estimation	
			Method	**Number of dates (Min)**	**Method**	**Number of dates (Min)**
ERS-2 SAR	1997-1998	VV	Temporal change	2	Agro-meteorological model (AMM)	3
ASAR APP	2007-2008	HH,VV	Single date	1	Statistical model	3
TerraSAR-X	2010-2011	HH,VV	Single date	1	Statistical model	3
CSK PP	2013-2014	HH,VV	Single date	1	Statistical model	3
RS-2	2013-2014	VV,VH	Temporal change	2	Statistical model	3

In-situ data

Thoai Son was the main district for the Autumn-Winter rice season in 2013, with Chau Thanh district as a secondary area (Figure 1). A total of 40 sample fields were used – 30 in Thoai Son, 10 in Chau Thanh.

The measurement campaign was carried out in close collaboration with the An Giang University for the Autumn Winter (AW) rice season 2013, Winter Spring (WS) and Summer Autumn (SA) rice season 2014.

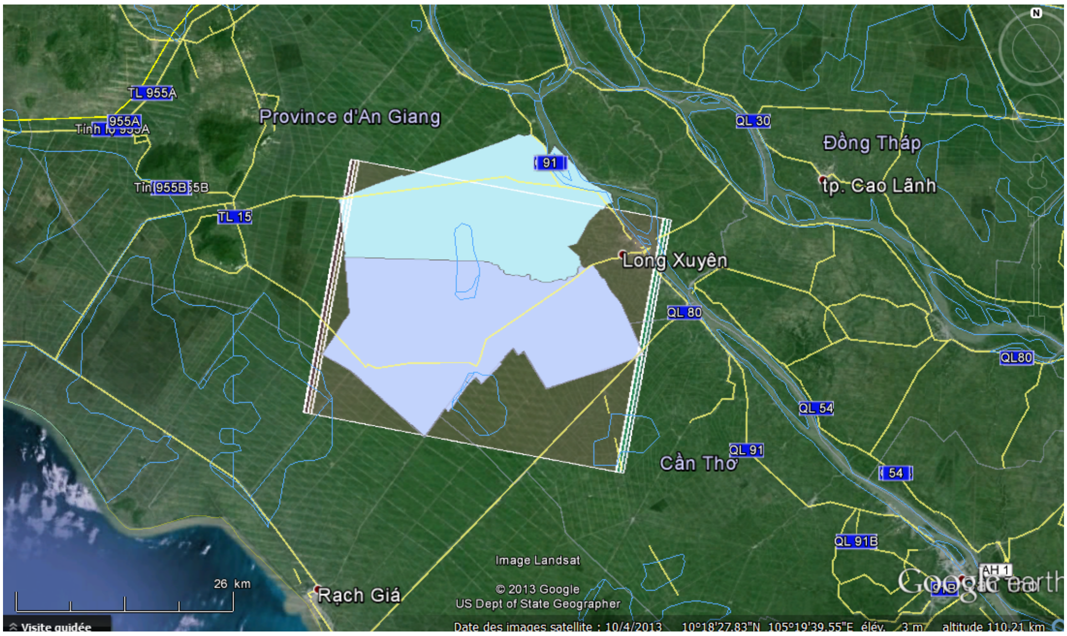


Figure 4 - Cosmo SkyMed frame of Thoai Son and Chau Thanh.

Rice parameters collected in situ:

Rice parameters		Description	Equipment
General parameters: Information from farmers	Paddy variety	Ex.: Jasmine, IR 64	
	Method of planting	Direct sowing/ transplanting	
	Sowing date	Date of direct sowing or days after sowing	
	Sowing density	Number/weight of seeds per ha	
	Use of fertilizer	Fertilizer type, amount, date	
	Transplanting date (if transplanting)	Date of transplantation or days after transplantation	
Observations and height measurements 19 August 29 August 13 September 15 November 23 November	Plant phenological stage	Seeding, transplanting, tillering, heading, flowering, ripening, ready to harvest	
	Water layer height (cm) Soil conditions	If not flooded, soil conditions (clods, moist, wet, dry.)	
	Plant height (cm)	Above water layer	Tape
	Use of fertilizer/ pesticides	Type, amount, date	Farmer information
Observations and intensive measurements 4 September 25 September 6 October 17 October 28 October 9 November	Wet weight per m² (g)	Above water biomass (moist weight by m²)	Cut all plants from defined areas (min 50 x 50 cm)
	Dry weight per m² (g)	Objective is to measure the dry biomass per m²	Oven dry (105° during 24 hours)
	Area of leaves / 50x50cm	Objective is to derive leaf area index (LAI)	Photo Xerox copy of leaves
	Moist and dry biomass of panicles per m²		

Harvest and after harvest	Date of harvesting	
	Yield (kg/m^2)	Information from the farmer

2014 Results

The team reported some preliminary results of rice monitoring using RADARSAT-2 data at the *2014 International Workshop on Using Remote Sensing for Crop Area Monitoring and Yield Estimation*, held in Taichung, Taiwan.

A progress report was also sent to CSA in September 2014, and some excerpts are presented on the following page.

General, leaf, and panicle parameters have been collected in the field to coincide with satellite acquisitions, along with field images. Their polarization ratio results exhibit the characteristic backscatter variation over the growing period for both Radarsat-2 (shown below) and COSMO-SkyMed.

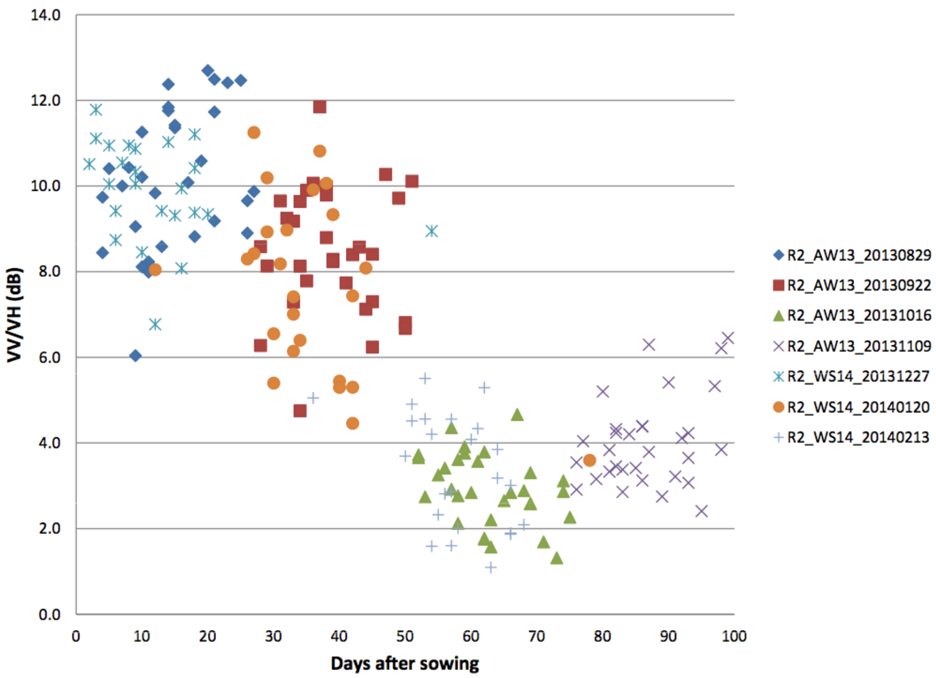


Figure 9 - Backscatter variation over the growing period (Radarsat-2)

They have completed rice area and yield assessments for multiple growing seasons with both COSMO-SkyMed and Radarsat-2, and the results are summarised in the following figure.

Table 9 - COSMO-SkyMed and Radarsat-2 rice area and yield assessment

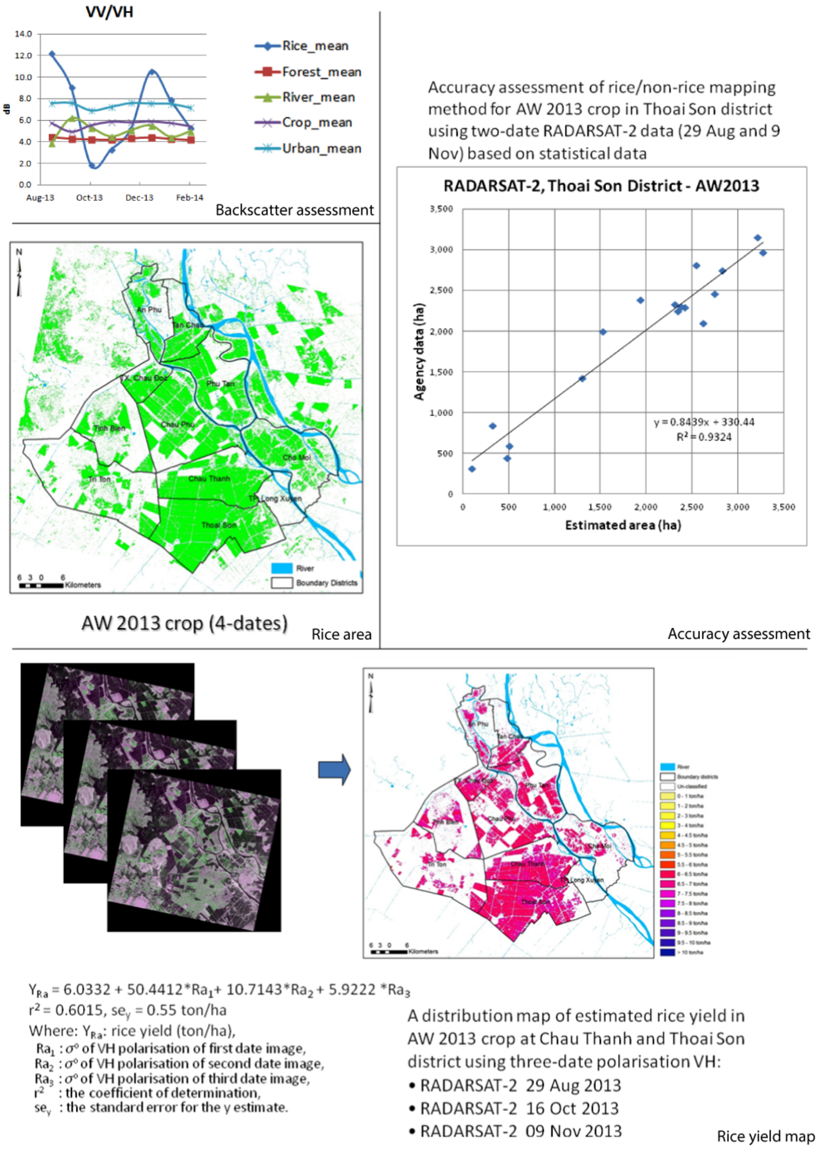
No.	Rice area		Rice yield		Note
	Mapping	Percentage error	Yield estimation	Percentage error	
AW2013 – CSK	X	2.7% (TS) -2.5% (CT)	X	-0.5% (TS&CT)	
AW2013 – RS2	X	-1.5% (TS) -7.5% (CT)	X	-0.5% (TS&CT)	
WS2014 – CSK	X	-7.7% (TS) -13.5% (CT)	N/A		
WS2014 – RS2	X	-1.1% (TS) -13.8 %(CT)	X	-13.2% (CT)	Yield AA: Not yet for TS
SA2014 – RS2					Ongoing

TS: Thoai Son; CT: Chau Thanh
AA: Accuracy Assessment

SOAR-JECAM Radarsat-2 Report – Vietnam (South)

The project was based on previous studies (such as RICEMAN "Rice and mangrove monitoring in Southern Vietnam") and had the primary mission of mapping rice planting area distribution, and estimating rice yield using multi-temporal satellite imagery. Radar data from ENVISAT ASAR and TerraSAR-X has been used in the past to map rice area in the Mekong Delta (Lam Dao Nguyen and Hoang Phi Phung, 2012), monitor rice crops (Lam Dao Nguyen et al., 2012), and estimate rice yield (Lam Dao Nguyen et al., 2009), and this project aims to exhibit the utility of Radarsat-2 for the same purposes.

Preliminary results



Conclusions

The method of rice mapping using VH polarization of multi-temporal RADARSAT-2 data produces good results for the Autumn-Winter crop season 2013. The study will continue to evaluate methods for rice mapping and yield estimation in the various rice crop seasons.

Summary

- Production of Mekong Delta rice distribution maps using MODIS and ScanSAR data are ongoing.
- Rice yield estimation maps have been made for An Giang province for the AW2013 season (CSK, R2) and WS2014 (R2).
- They are working to compile a GIS database for rice.
- The team is looking forward to performing a comparison of results derived using C-, L-, and X-band data, as well as to study the correlation between NDVI and backscatter for phenology.

3.6. South Korea

Organisation

Climate Change and Agro-ecology Division, Department of Agricultural Environment

National Academy of Agricultural Science(NAAS)

Rural Development Administration(RDA), Korea

Remote Sensing in Agricultural Applications: Crop mapping and acreage, crop growth, crop yield estimation and forecast, crop damage assessment

Basic objectives

NAAS and RDA are currently working on MODIS-based rice yield estimation, crop damage assessment, and crop mapping and acreage.

Next year, NAAS and RDA will continue working on MODIS-based rice yield estimation, crop damage assessment, vegetable crops mapping and acreage, vegetable crop monitoring for growth and production, and estimation of evapo-transpiration in paddy fields using a water and energy balance model. They will also use Agro met data to estimate/forecast crop yield.

Satellite data

The South Korean team is using data from Landsat, MODIS, RapidEye, RADARSAT-2, Kompsat-2 and 3, as well as UAV. Data is acquired every month during crop growing periods in each study area, however some optical images are contaminated with clouds, rendering them unusable for data analysis.

The projects are still based mostly on optical and TIR imagery, however they are also planning to use Radar imagery from missions such as Radarsat-2 to assess damage in rice paddy fields (for example that caused by typhoons).

The Radarsat-2 data requested was as follows: FQ, Wide FQ, and ScanSAR Wide DP, SLC or path image for processing level (30~45° of incidence angle).

In situ data

Satellite data is supplemented by in situ data, including information on crop growth and land use. The sampling time is different between crops and is based on their individual growth calendar.

2014 Results

We have established a ground-based radar scatterometer system with L-, C-, and X-band antenna and automatically collected radar scattering signature with a 10 min interval for rice, soybean, wheat, and corn several years(2007~2013) and found relations of agronomic variables to backscattering coefficient from the crop canopy.

3.7. Lao P.D.R – Savannakhet Province

No report received.

3.8. China – Taishan, Guangdong Province

No report received.

3.9. India – West Bengal State

No report received.

3.10. Japan – Tsuruoka, Yamagata Prefecture

Organisation

Corresponding agency, R&D for satellite/in-situ data processing

- Japan Aerospace Exploration Agency (JAXA)
- Remote Sensing Technology Center of Japan (RESTEC)

TDS site management, R&D for in-situ data collection system and field data processing

- Tsuruoka National College of Technology
- University of Aizu

Basic objectives

The Japanese team is mainly focused on producing rice crop area estimates & maps, and are doing so using their rice crop area estimate software called "INAHOR". The team has already provided this software along with a training course to other Asia-

RiCE teams and countries including Indonesia, Thailand, Vietnam, Laos, and The Philippines. The Japanese team is also focused on the development and provision of near real-time agro-met information products via the internet for Asia-RiCE phase 1A countries (Indonesia, Thailand, and Vietnam), The Philippines, and Japan.

The current and future objectives of the Japanese team are summarised below:

Currently

In-situ data collection by field survey

Development of an automatic in-situ data collection system

Paddy field identification using INAHOR with Radarsat-2 data and its validation

2015

In-situ data collection by field survey and the development automatic system

Paddy field detection by ALOS-2, Sentinel-1A, TerraSAR-X, and other SAR missions and its validation

Phenological stage classification by the blending of a collection of SAR (HH+HV, VV+VH) and optical data

In the near future

Development of a near real-time monitoring system for rice area identification and phenological stage classification including inundation, planting, vegetative, ripening, and harvesting.

In the future, the Japanese team will continue their in situ data collection by field survey and auto DCS; integrate other sources of data such as ALOS-2, Sentinel-1A, TerraSAR-X; and refine INAHOR.

In terms of the Asia-RiCE target products, the progress of the Japanese team is summarised in the following table:

Product	Progress
Rice Crop Area Estimates & Maps	Produced the software "INAHOR" for rice crop area identification and estimation Preliminary results of rice crop area maps around the TDS derived from ALOS PALSAR and Radarsat-2 data with INAHOR
Crop Calendars/Crop Growth Status:	Crop intensity map over the Asian region derived from time series MODIS data
Crop Damage Assessment	Drought index generated from satellite derived precipitation data (GSMaP) and LST (MTSAT and Himawari LST) Trying to develop flood monitoring products from microwave radiometer data (GCOM-W AMSR-2 and other available microwave radiometers), SAR and optical data
Agro-met Information Products	Web-based satellite derived agro-met data provision system "JASMIN", which provides precipitation, PAR, soil moisture, LST, vegetation index (NDVI), and drought index.
Yield Estimation & Forecasting	Trying to derive an empirical model for rice crop yield/production by using satellite derived agro-met information

Satellite data

CSA/MDA have provided 8 Radarsat-2 scenes from 2014/113 to 2014/178. The data is wide fine mode, 8 m spatial resolution, and in SLC format. The acquisitions are summarised in the following:

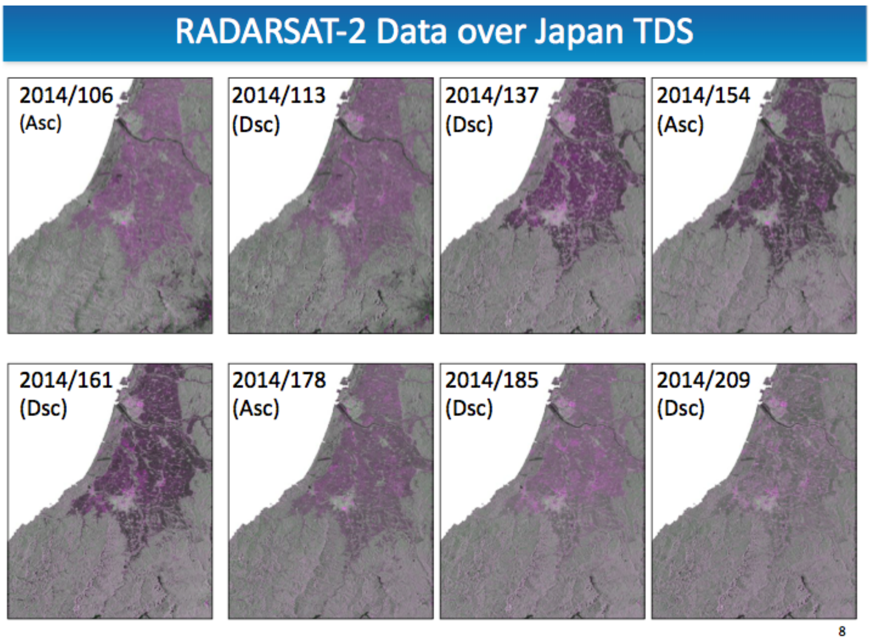
RADARSAT-2 : Observation Plan for Japan TDS

Date	UTC	Site	Beam	Pass
16-Apr-2014	08:36:08.331	Japan	Wide Fine	Ascending
23-Apr-2014	20:46:23.634	Japan	Wide Fine	Descending
10-May-2014	08:36:08.331	Japan	Wide Fine	Ascending
17-May-2014	20:46:23.634	Japan	Wide Fine	Descending
3-Jun-2014	08:36:08.331	Japan	Wide Fine	Ascending
10-Jun-2014	20:46:23.633	Japan	Wide Fine	Descending
27-Jun-2014	08:36:08.331	Japan	Wide Fine	Ascending
4-Jul-2014	20:46:23.633	Japan	Wide Fine	Descending
21-Jul-2014	08:36:08.331	Japan	Wide Fine	Ascending
28-Jul-2014	20:46:23.633	Japan	Wide Fine	Descending
14-Aug-2014	08:36:08.331	Japan	Wide Fine	Ascending
21-Aug-2014	20:46:23.633	Japan	Wide Fine	Descending
7-Sep-2014	08:36:08.331	Japan	Wide Fine	Ascending
14-Sep-2014	20:46:23.633	Japan	Wide Fine	Descending
1-Oct-2014	08:36:08.331	Japan	Wide Fine	Ascending
8-Oct-2014	20:46:23.633	Japan	Wide Fine	Descending
25-Oct-2014	08:36:08.331	Japan	Wide Fine	Ascending
1-Nov-2014	20:46:23.633	Japan	Wide Fine	Descending
18-Nov-2014	08:36:08.331	Japan	Wide Fine	Ascending
25-Nov-2014	20:46:23.633	Japan	Wide Fine	Descending

Acquired

Wide Fine Mode
- 5.2x7.7 m
- 170x150 km
- Inc. 20-40 deg
- VV+VH

7



The Radarsat-2 data is mainly used for paddy rice area identification, and is currently validated with in-situ data collected by field survey and the automatic data collection system. Radarsat-2 wide fine mode data with 8m spatial and high temporal resolution (more than once a month) enables the team to map paddy area in detail and compare it easily with paddy locations collected by field survey. In addition, Radarsat-2 wide fine data could be a useful tool for rice phenological stage monitoring, and they are currently trying to do this using dual polarized data (VV/VH).

The team is also using/will use data from ALOS-2, Sentinal-1A, TerraSAR-X, Terra/Aqua(MODIS), Landsat, GCOM-W, GPM/DPR (GSMaP), MTSAT-1R/2, and Himawari-8.

In situ data

Field surveys were carried out from June 2nd to the 4th 2014 and automatic in-situ data collection systems have been installed.

The in situ data collected at the site includes location, plant height, daily field photos, and hourly meteorological parameters (precipitation, temperature, solar radiation, and wind velocity/direction).

2014 Results

A field survey was completed in July, the autonomous field DCS have been installed, the INAHOR tool has been developed (validation ongoing with Radarsat-2 data), JASMIN has been improved, and work has continued on the SAFE projects.

8 Radarsat-2 images have been received this year and have been used with the INAHOR tool to estimate paddy areas and yields.

The Japanese team has also compared Radarsat-2 SAR backscatter and NDVI with reference field photos, as shown in the following figure.

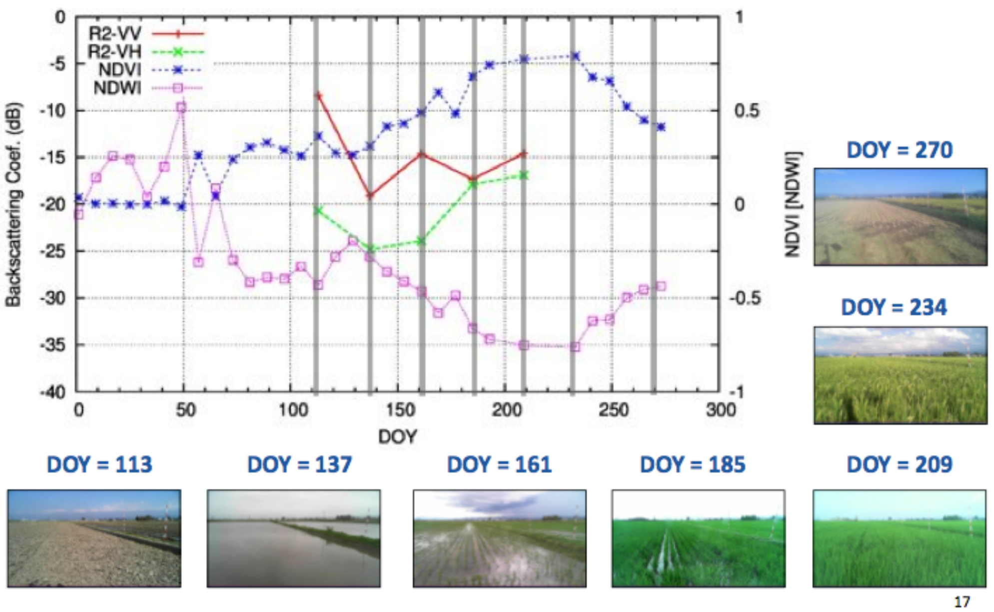


Figure 10 - ***Radarsat-2 SAR backscatter and NDVI compared with with reference field photos***

Publications

Asia Rice Crop Team (Asia-RiCE) Activity in GEO-GLAM. Sobue, S., Oyoshi, K., Okumura, T., Tomiyama, N., and Kaneko, Y., Journal of the Remote Sensing of Japan, 34(4), pp.314-318, 2014. (with English abstract)

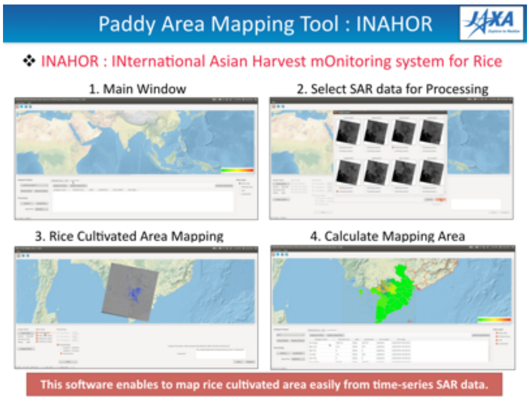
To improve food security information using Earth observation national/ regional/global scale - Reflect the inter-dependent nature of the food price and security challenges-. Sobue, S., The 7th GEOSS Asia- Pacific Symposium , Tokyo, Japan, 27 May. 2014.

Introduction to Asia Rice technical demonstration sites II. Japan, Indonesia, Vietnam, Oyoshi, K., Tomiyama, N., Okumura, T., Sobue, S., Supriatna, W. Shofiyati, R., Nguyen, L. D. and Toan Le T., The 7th GEOSS Asia- Pacific Symposium , Tokyo, Japan, 27 May. 2014.

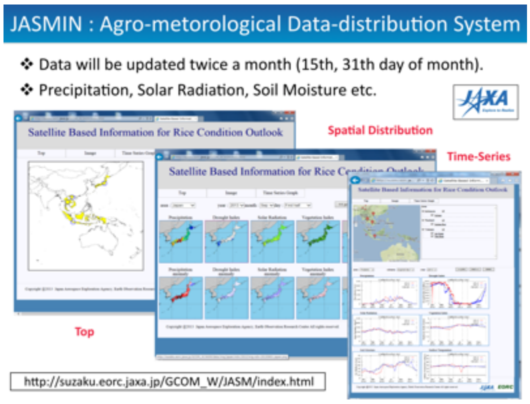
Rice Crop Monitoring by Synthetic Aperture RADAR (SAR) in Southeast Asia", Oyoshi, K., Tomiyama, N., Okumura, T., Sobue, S., Supriatna, W. Shofiyati, R., 7th IGRSM International Conference and Exhibition on Remote Sensing and GIS, KL, Malaysia, 22 Apr. 2014.

Example results and tools – Japan

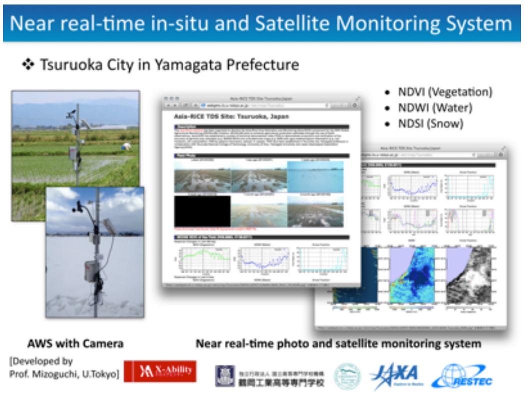
INAHOR



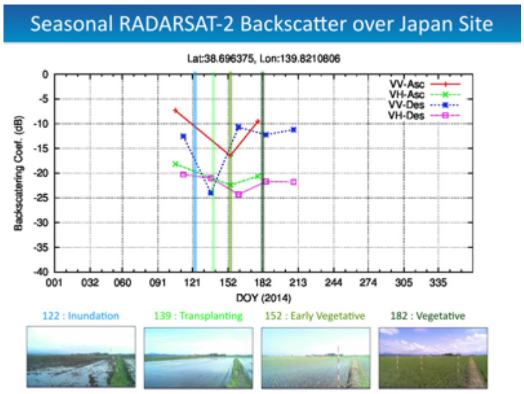
JASMIN



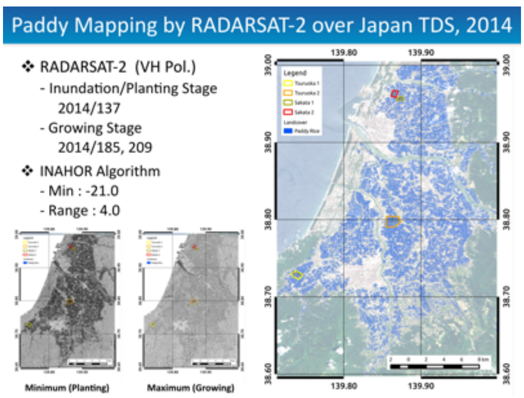
Near real-time auto in-situ data collection system



Comparison with RADARSAT-2 data and field photo



Paddy Field Mapping by RADARSAT-2 (VH Pol.) data with INAHOR



3.11. Malaysia – IADA Barat Laut Selangor Province

Organisation

DOA (Department of Agriculture) – Supports the rice activities, given their link to farmers.

MARDI (Malaysian Agricultural Research and Development Institute) – Research agency that will potentially be involved as imaging specialists.

MRSA (Malaysian Remote Sensing Agency) – Research agency that will potentially be involved as imaging specialists.

IADA BLS (Integrated Agriculture Development Area – Barat Laut Selangor) – Providing support to study site activities

UPM (University Putra Malaysia) – Research agency that will potentially be involved as imaging specialists.

Basic objectives

The main objective of the team is to investigate the potential of soil salinity mapping using Radarsat-2 and other data in the Integrated Agriculture Development Area – Barat Laut Selangor (IADA-BLS) rice farming area. In the near future they will be analysing various types of soil salinity conditions in the rice farming area, trying to determine the nutrient health status of paddy from space, monitor paddy pests and diseases, and trying to estimate paddy area and yield.

In terms of the Asia-RiCE target products, the Malaysian team's main objective is to produce rice crop area/yield estimates and maps.

Satellite data

Radarsat-2 data was acquired (under SOAR-JECAM) on the 21st of May 2014 (112741-GMT) and the 1st of August 2014 (112740-GMT). They have only managed to download the 1st of August, HH polarized data so far. Four other acquisition requests have been bumped by higher priority commercial requests.

2014 Results

Radarsat-2 data will be used for soil salinity analysis. To date no results have been published as the project has only just commenced, and they are awaiting Radarsat-2 data.

3.12.Chinese Taipei (Taiwan) – Chang Hua, Yun Lin, and Chiayi Counties

Organisation

Center for Space and Remote Sensing Research (CSRSR), National Central University, Taiwan.

Taiwan Agricultural Research Institute (TARI), Taiwan.

Basic objectives

The current and future objectives of the Taiwanese team are summarised below:

Currently

Mapping rice cropping patterns with MODIS-Landsat/SPOT fusion data;

Processing Radasat-2 data for the first crop (Feb-Jun); and

Setup standard ground survey data protocol.

Collecting field data.

2015

Maps of rice cropping systems (from MODIS-Landsat/SPOT fusion data and Radarsat-2 data);

Rice crop yield models (from MODIS-Landsat/SPOT fusion data and Radarsat-2 data);

In the near future

Crop damage assessment.

In terms of the Asia-RiCE target products, the focus of the Taiwanese team is on rice crop area estimates and maps, crop calendars/crop growth status, and yield estimation and forecasting.

Satellite data

The Canadian Space Agency provides Radasat-2 data, and 14 scenes have been received from February to September 2014. The data is dual polarized VV-VH, and has a spatial resolution of 4.79 to 6.23m. TARI is now processing the Radasat-2 data and producing maps for the first rice crop season (February to June) in the study region. The data will also be used for crop damage assessment (including soil moisture and flood assessments).

In situ data

TARI is responsible for field data collection, and they collect information on rice crop sowing and harvesting dates, rice parameters (e.g. plant height, biomass, number of leaves, etc.) as well as other field parameters (e.g. soil moisture, water depth in the field, etc.).

2014 Results

Initial findings from rice crop mapping with MODIS/Landsat or SPOT fusion data as well as the mapping results from Radarsat-2 data and others will be shared in the future.

3.13. Philippines – Nueva Ecija

Organisation

IRRI – The International Rice Research Institute and PhilRice – The Philippine Rice Research Institute. IRRI conducts the rice area mapping using Radarsat-2 SLC within the MAPscape-RICE software and PhilRice lead the ground validation work, although the schedule for groundwork is linked to a parallel observation acquisition schedule using TerraSAR-X data over the same region (Nueva Ecija).

Basic objectives

Currently

Test the applicability of Radarsat-2 for rice area mapping and detection of start of seasons dates and compare the results to TerraSAR-X

Next year

Complete the assessment above and await news on further funding to continue activities under Asia-RiCE.

In the near future

Explore ways to link Asia-RiCE activities in Nueva Ecija to ongoing projects:

- The Swiss Agency for Development and Cooperation-funded RIICE project (http://www.riice.org) is exploring both public and private sector applications in food security and crop insurance with the aim to build capacity in-country to sustain such services.
- Another project conducted by the Asian Development Bank and supported by the Japan Fund for Poverty Reduction aims to improve the quality and timeliness of rice crop area and production estimates and forecasts through SAR data (Innovative Data Collection Methods for Agricultural and Rural Statistics, http://www.adb.org/projects/46399-001/main).
- IRRI and PhilRice are collaborating on a national scale rice information system for the Philippines called PRiSM – funded by the Philippines DA (http://philippinericeinfo.ph/) . The aim is to combine Sentinel-1 based SAR rice crop monitoring with crop health assessments and massive scale field information from smart phones to develop an integrated online system for the DA related to municipal level rice area, production and loss estimates, damage reports, crop health production situations and to link to

ongoing extension work using Rice Crop Manager services to provide farmers with pre and in season advisories for sustainable and profitable rice crop production.

– The team desires to also use HV and HH-HV Radarsat-2 data, as well as to acquire the data in the opposite direction. Cloud computing is a priority, as it is likely the only way they can overcome technical limitations related to the storage and processing of data. IRRI would like to advance methods for combining ascending and descending images.

In terms of the Asia-RiCE target products, the progress of the Filipino team is summarised in the following table:

Product	Progress
Rice Crop Area Estimates & Maps	We could not develop any rice products from the dry season due to too many cancellations in the acquisition plan. The wet season is still ongoing and we have not produced any products yet. The wet season acquisitions have been less affected by cancellations than the dry season so we are hopeful of producing good products come season end in November 2014.
Crop Calendars/Crop Growth Status:	Same as above.
Crop Damage Assessment	On September 17, 2014, the Low Pressure Area east of Visayas developed into a tropical storm (TS) named Mario (International name: Fung-wong). Typhoon Mario caused heavy rainfall and severe flooding in several regions in Luzon before it exited the Philippine Area of Responsibility on September 22, 2014. As of September 30, official figures on damages to agriculture in five regions are estimated at 2.8 billion pesos with an estimated 2.3 billion pesos in damages to rice and corn crops (NDRRMC Situational Report 17). These floods were captured in the TerraSAR-X series because we had images every 11 days on Sept 10 (before the storm) and Sept 21 (after the storm). However the radarsat-2 images were on Sept 7 (before) and Sept 26 (after) and most flood waters had receded by the 26th so we did not detect any flooding in the Radarsat series
Agro-met Information Products	
Yield Estimation & Forecasting	We have not yet conducted yield estimation using the crop parameters derived from Radarsat-2 data. This is planned for Q1 2015 and can be compared to the same yield estimation conducted with TerraSAR-X. Our approach is based on calibrating a crop growth simulation model (CGSM) called Oryza2000 using crop growth parameters derived from the change in backscatter in the vegetative stage of the rice crop. The yield is modeled on a pixel basis but we aggregated the yield estimates to municipal level due to the large errors and uncertainties at pixel level.

Satellite data

Satellite data is used for area estimation, start of season estimation, loss estimation from flooding, yield forecasting and yield estimation. The details of the Radarsat-2 data acquired over the Nueva Ecija site are listed in the following table. The second table specifies the dates and details of the TerraSAR-X data acquired over the same site.

Specification	Ascending	Descending
Standard Geo-referenced. **Pass: DESC** **Look: Right** **Beam: WideF (F0W2)** **Tx: V** **Rx: H+V**	24-Dec-13	29-Dec-13
	17-Jan-14	22-Jan-14
	10-Feb-14	15-Feb-14
	06-Mar-14	11-Mar-14
	30-Mar-14	04-Apr-14
	23-Apr-14	28-Apr-14
	17-May-14	22-May-14
	03-Jun-14	22-Jun-14
	27-Jun-14	16-Jul-14
	21-Jul-14	09-Aug-14
	14-Aug-14	02-Sep-14
	07-Sep-14	26-Sep-14
	01-Oct-14	20-Oct-14
	25-Oct-14	13-Nov-14

Site ID 13 (Philippines, Nueva Ecija)		
Satellite and band	TSX, X	
Swath [km]	100 x 150	
Incidence angle [°]	45	
Polarization	HH	
Mode	ScanSAR	
Ground resolution [m]	10	
Orbit cycle [days]	11	
Orbit direction	Ascending	
Scene center, area (sq km)	15.71°N-120.75°E, 15,000	
Acquisition information planned	**Date**	**Time**
	2013-05-25	10:06 AM
	2013-06-05	10:06 AM
	2013-06-16	10:06 AM
	2013-06-27	10:06 AM
	2013-07-08	10:06 AM
	2013-07-19	10:06 AM
	2013-07-30	10:06 AM
	2013-09-01	10:06 AM
	2013-09-12	10:06 AM
	2013-09-23	10:06 AM

In situ data

Ground data were taken to match the schedule of the RIICE acquisitions.

Field observations were performed throughout the season in up to 20 paddy fields within each footprint. These fields were selected, with the farmers' consent, prior to the start of the rice season and the image acquisition schedule. Observations were made on or as close to the image acquisition date as possible, depending on national holidays or other events that prevented easy access to locations. Observations included latitude and longitude from handheld GPS receivers, descriptions and photos of the status of the field, plant height, water depth, weather conditions, crop stage, and leaf area index (LAI). The same field data collection protocols were used at all sites. LAI measurements were taken only during visits between seedling and flowering stages and these were recorded non-destructively using the same equipment at each site: an AccuPAR LP-80 Ceptometer (Decagon Devices, Inc., Pullman, WA, USA). The specific model of the GPS and digital cameras varied across sites. At the end of the season, the farmer was interviewed to collect information on the rice variety, water source, crop management and establishment practices, and inputs such as pesticide and fertilizer.

In total, 228 locations were regularly monitored across the 13 footprints, with 1,922 separate visits made to these locations to collect in-season information on the status of the rice crop, an average of 8 visits per location and 18 locations per footprint.

A validation exercise was conducted for each footprint to assess the accuracy of the rice classification. We first considered the regular sampling grid and random selection of locations as appropriate methods to select representative and spatially well-distributed samples. However, these approaches were quickly deemed too time consuming and too expensive to apply over 13 sites covering 46,500 sq km. For these reasons, a rapid land-cover appraisal method was adopted to collect land-cover information at approximately 100 locations throughout each footprint with these points split 50/50 between non-rice points and rice points. This conforms to the minimum number of samples per land-cover class accounting for both statistical sampling requirements and practical considerations given the available resources and accessibility.

Field staff conducted multi-day journeys through each footprint, following routes based on local knowledge of the land cover. GPS coordinates, photos and land-cover descriptions were collected at each location. These map validation assessments were generally conducted in-season, in the reproductive or ripening stage before harvesting, but in some cases the assessment was conducted post-season and hence rice stubble and farmer surveys were used to confirm that the observed post-harvest situation reflected the presence of a rice crop during the monitored season. Locations were chosen such that the land cover was homogeneous in a 15m radius around each GPS point for sites using 3m resolution imagery and a 50m radius for sites using 10m or 15m resolution imagery.

2014 Results

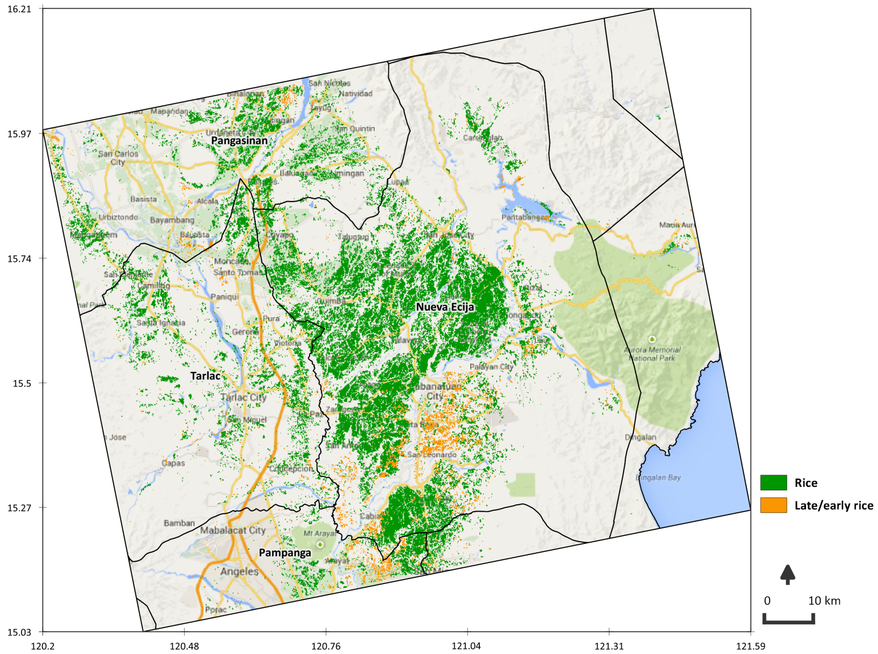
Season is ongoing, no reports yet. We will compare the rice area map products from Radarsat-2 and TerraSAR-X for the current wet season (June-Nov 2014). We will also compute the start of season and end of season yield estimates using crop growth parameters derived from the SAR series.

Plans for Radarsat-2 will depend on the cost effectiveness of the data as part of operational rice monitoring plans that will incorporate data from Sentinel-1, ALOS-PALSAR-2, CSK, TSX and RISAT-1.

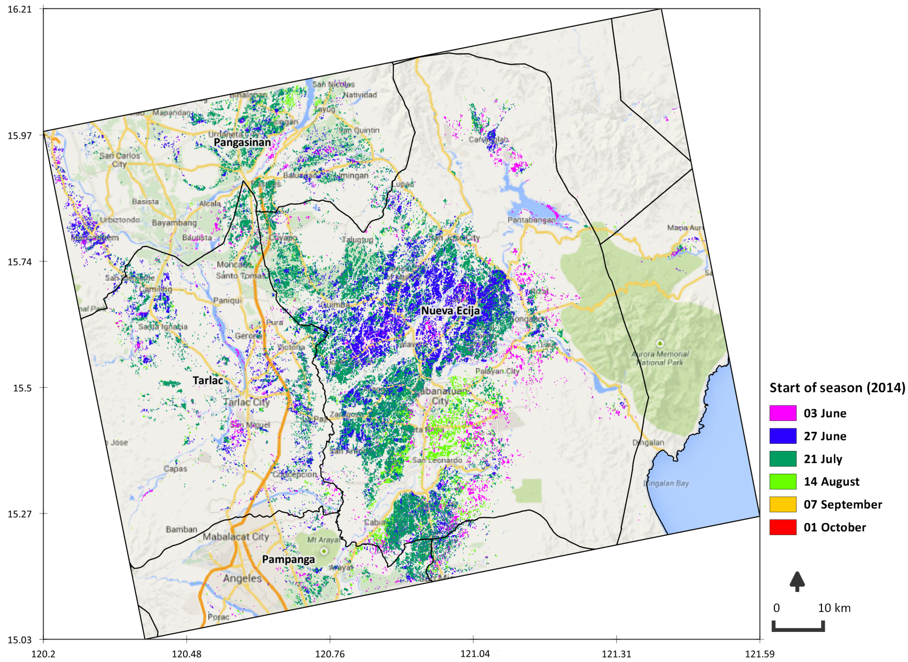
The team from the Philippines have found X- and C-band backscatter signatures to be very different, with X- peaking earlier. They have been able to compare Radarsat-2 and TerraSAR-X data throughout the season. TerraSAR-X tends to detect more rice, possibly due to its more frequent revisit.

IRRI have assessed the accuracy of their algorithm using each of the data sources, finding 87.6% field identification accuracy with TerraSAR-X and 82.7% for Radarsat-2 (HH polarization only, one direction), however they had more TerraSAR-X ground survey points. HH-HV is better than VV-VH in their data processing chain, as it is much better at detecting water at the start of a season.

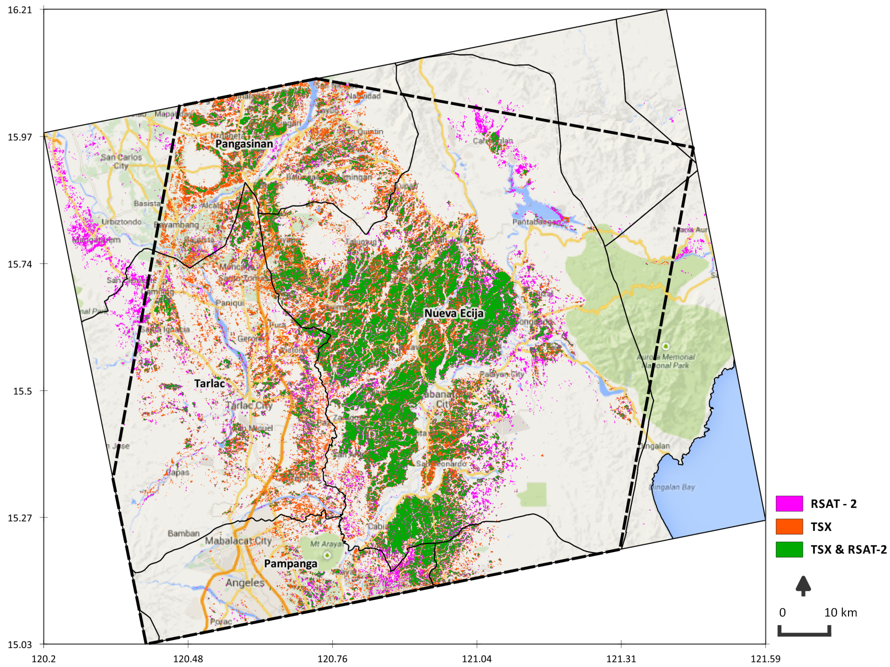
Some maps and statistics generated using Radarsat-2 are shown on the following pages.



Rice area in wet season from Radarsat-2



Start of Season from Radarsat-2



Comparison of rice area detection Radarsat-2 and TSX

Confusion matrix computations from the "Accuracy Data" worksheet				
		Predicted class from the map		
		Rice	Non-Rice	Accuracy
Actual class from survey	Rice	57	28	67.1%
	Non-Rice	0	77	100.0%
	Reliability	100.0%	73.3%	82.7%

Average accuracy	83.5%
Average reliability	86.7%
Overall accuracy	82.7%
Kappa index	0.65

RADARSAT-2 preliminary rice map – 2014 wet season accuracy assessments

4. IRRI Cooperation

4.1. MODIS Crop Maps and Calendars

IRRI has developed a map of the spatial extent of rice in Asia derived from MODIS data, along with a global map of rice seasonality with information on planting and harvesting dates in up to three seasons per year. IRRI plan to share the map with the community and GEOGLAM as a research output of GRiSP/RIICE.

Several Asia-RiCE partners contributed to the map by providing rice extent data in GIS format, and also performing assessments of the quality of the MODIS map for their country.

The resulting materials will be research grade products and will be a significant upgrade to existing maps, particularly those in use by the GEOGLAM Crop Monitor. The maps are a valuable contribution by IRRI, and will be a great resource for Asia-RiCE and the wider community. The improvements enabled by Asia-RiCE and its members are also a great example of the value of the Asia-RiCE initiative.

5. Conclusions and Way Forward

5.1. Objectives for 2015 and Beyond

In 2015 and beyond, Asia-RiCE will be working to:

- Revise the Asia-RiCE Work Plan and Space Data Requirements documents to reflect the evolution of itself and GEOGLAM.
- Continue working with Phase 1A TDS to generate target products.
- Continue working closely with CSA, ESA, JAXA, ISRO and other CEOS agencies to ensure continuity of data supply for the TDS.
- Continue Sentinel-1 reference site coordination with ESA/IRRI/RIICE/NCU, and work with ESA to explore the possibility of further expansion to other SE Asian sites during the ramp-up phase of the mission.
- Continue working with CESBIO to maximise the potential outcomes from the ESA DUE Innovator III program.
- Initiate Phase 1B to develop provincial-level rice crop area and yield estimations and expand the FAO AMIS crop outlook trials to other TDS, and possibly move to full country "wall-to-wall" activities in Thailand.
- Engage with Asia-regional stakeholders such as the Asian Development Bank (ADB) (possibly through an existing JAXA-ADB Technical Assistance (TA) agreement)
- Externally promote TDS rice crop area and yield estimations and FAO AMIS outlook activities.

5.2. Upcoming Data Sources

As noted in Section 2.4, Sentinel-1A data over the Mekong Delta reference site should be available shortly, pending final calibration of the satellite by ESA. It is hoped that coverage for Asia-RiCE will be expanded to other SE Asian sites during the ramp-up phase, with an initial focus on the Phase 1A TDS.

Asia-RiCE is also awaiting acquisition and delivery of 42 TerraSAR-X scenes over Japan, Indonesia, and South Vietnam.

ALOS-2 data will be supplied to Asia-RiCE TDS through K&C Phase 4, however it is currently uncertain how much data will be received and for which sites. The satellite is currently in its commissioning phase, and more details should be available shortly.

It is hoped that Radarsat-2 acquisitions will continue into 2015, and that new sites will be included in the acquisition plans. CSA have initiated a new data access procedure for JECAM, and Asia-RiCE will also benefit. The Multi-User Request Form (MURF) should pave the way for more open access to Radarsat-2 data and facilitate services such as the SDMS cloud computing platform by allowing intermediaries to host and distribute data to end users. It is expected that the arrangement will improve data fluidity and open sharing.

5.3. Upcoming meetings

The Asia-RiCE team will continue to hold monthly teleconferences to coordinate on key issues and to share experiences and achievements. Meetings of opportunity will also be used for either partial or full face-to-face team meetings, and some potential meeting opportunities are summarised in the following table.

Meeting	Location	Date
SAFE	Vietnam (TBD)	June 2015 (TBD)
Asia-RiCE team meeting	TBD	TBD 2015
ACRS2015 – JAXA special session	Manila, Philippines	October 2015
SAFE/APRSAF	Bali, Indonesia	December 2015