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# Introduction and Background

## Introduction

This 2019 update of the Asia-RiCE Work Plan has been prepared to reflect the latest status of Asia-RiCE and to define Asia-RiCE Phase 3.

**GEOGLAM**

Asia-RiCE is the rice monitoring component of the Group on Earth Observations Global Agricultural Monitoring initiative (GEOGLAM). GEOGLAM aims to enhance agricultural production estimates through the use of Earth observations. It was developed in response to the G20 Agricultural Ministers’ concern about reducing market volatility for the world’s major crops. The initiative builds on recent advances in Earth observation technologies. These technologies have great potential to contribute to timely forecasts of crop production and early warnings of potentially significant harvest shortfalls.

The initiative’s goal is to strengthen the international community’s capacity to produce and disseminate relevant, timely, and accurate forecasts of agricultural production at national, regional, and global scales through the use of Earth observations.

**Importance of Rice Crop Monitoring**

Rice is the staple food for more than half of humanity – with 90% of the world crop grown and consumed in Asia. Global rice production has increased continuously in the last half-century, since the Green Revolution. In the same period, the use of chemical inputs, the introduction of modern high-yielding varieties with short growing cycles, and the increased access to machinery and irrigation systems have led to a linear growth of the crop yields (+0.05ton/ha/year) as well as to an increase of the number of crops per year (Food and Agriculture Organization of the United Nations, 2012).



Table 1 – 2017 Top 20 rice producing countries by megatonne (Mt) (Source: FAOSTAT)

Accurate information is needed on the spatial distribution of rice fields, water resource management, risk occurrence and annual production projections. However, most agricultural surveys rely mainly on statistics based on limited ground samplings at which data are extrapolated on a national scale. Although the census can provide statistical estimates, slow and unsystematic collection of data can limit the ability to make timely decisions.

Moreover, rice agriculture is strongly linked to environmental issues, from water management to climate change (methane emission). For these reasons, long term inter-annual monitoring is also required in order to study the production and cultural impacts of these factors. Satellite remote sensing can support this long-term monitoring requirement at regional and global scales.

Given the importance of rice, Asian participants in GEOGLAM formed an *ad hoc* team to ensure the appropriate representation of rice crop monitoring in the GEOGLAM initiative.

## Asia-RiCE & The Phased Approach

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.

Asia-RiCE has leveraged existing agricultural monitoring programs and initiatives at local levels to develop, exercise, and refine processes, and now moves on to full implementation and product generation using SAR (i.e., radar) and other Earth observation data for practical rice crop monitoring.

This activity (being implemented in phases) will contribute to Goal 2 and other Goals of the SDGs by improving rice crop productivity and reducing environmental impacts.

**Phase 1 (2013 – 2015)**

Phase 1A (2013-2014) consisted of four demonstration sites in three countries: Indonesia, Thailand, and Vietnam). Each of these was focused on the development of provincial-level rice crop area estimations. Note: Phase 1A only covered rice area statistics, maps, and yield estimates. In Phase 1B (2014-2015), additional technical demonstration sites in Chinese Taipei, Japan, and Malaysia were added.

**Phase 2 (2016 – 2018)**

Following the successful demonstration of the core functionality of Asia-RiCE, the initiative moved into Phase 2, which covered:

* Wall-to-wall SAR observation of selected countries and scaling-up rice crop monitoring using SAR from provincial-level to country/ region-level estimates (Vietnam & Indonesia);
* Expanding rice growth outlooks using satellite-derived agro-meteorological data for Laos, Cambodia, and Myanmar; and,
* Continuing rice growth outlooks for FAO/ AMIS and related agencies via GEOGLAM in collaboration with AFSIS (ASEAN+3 Food Security Information System) project.

Asia-RiCE is now in its third phase. For further details and outcomes of the previous phases, see the Implementation Reports: [2014](http://asia-rice.org/files/Asia_RiCE_Implementation_Report_v1.pdf), [2015](http://asia-rice.org/files/Asia-RiCE-2015-Implementation-Report_v1.pdf), [2016](http://asia-rice.org/files/Asia-RiCE-2016-Implementation-Report_v1.pdf), [2017](http://asia-rice.org/files/Asia-RiCE-2017-Phase2-Implementation-Report_v2_29-3-2018.pdf).

**Phase 3 is expected to run from April 2019 to March 2021.**

## Objectives of Asia-RiCE Phase 3

Asia-RiCE Phase 3 (April 2019 – March 2021) aims to:

* Promote the use of EO data for wall-to-wall rice crop monitoring in cooperation with GEORICE and Asia-RiCE team members and international donors;
* Promote the use of new generation tools for big EO data analysis, such as the Open Data Cube and cloud-based systems with available data sources and tools (such as INAHOR and GEORICE);
* Continue to promote the use of the Open Data Cube in Vietnam, Cambodia, and Chinese Taipei in cooperation with VNSC, GA, ESA/CNES, NSPO, and JAXA;
* Promote outcomes, output applications, research results, and progress at international conferences such as the ESA Living Planet Symposium, IGARSS, ACRS, etc.;
* Continue to promote the generation of rice crop outlooks in Asia using the agro-met information from Japan (JASMIN) and India (MOSDAC).

In addition to these practical aspects, the following research topics are also priorities:

* Research around creating ARD time series from SAR and optical data for rice crop monitoring using Open Data Cube;
* Rice crop models for yield estimation;
* Methane emission from paddy fields;
* Standardization of field surveys for validation of results at national and regional scales (in cooperation with GEORICE);
* The practicality of potential integration of operational systems such as FASAL (India);
* Capacity building in Asia in cooperation with available training centres such as ARTSA, IIRS, CSSTEAP.

## Stakeholders

Asia-RiCE aims to coordinate the evolution of a system of systems which will be greater than the sum of the individual parts and which will facilitate the sharing of know-how, develop capacity, and support region-wide capabilities that reflect the inter-dependent nature of food price and security challenges.

A broad range of stakeholders are of relevance to Asia-RiCE:

* **National governments** and their agencies responsible for their various rice crop monitoring and food security systems and capabilities;
* **Regional intergovernmental coordination bodies** with ambitions in this domain, such as ASEAN. Asia-RiCE works with the ASEAN Food Security Information System (AFSIS) to provide crop condition overview information and outlooks to the GEOGLAM Crop Monitor and AMIS.
* **Remote sensing organisations** and their coordination groups that can support supply of the necessary space data – these include the space agencies of Japan, China, India, Indonesia, Korea, Thailand, Vietnam and others; as well as the regional space agency forum APRSAF, SERVIR Mekong, and the international Committee on Earth Observation Satellites (CEOS);
* **UN agencies** and their regional activity groups, such as FAO and ESCAP; and,
* **Key donor organisations** including global (e.g., World Bank), regional (e.g., Asian Development Bank), and national (e.g., JICA) bodies.

Participation in the *ad hoc* team has to date been predominantly by national implementing agency and space agency representatives. However, the intention is to ensure that the full spectrum of stakeholders are further engaged in implementation of Asia-RiCE Phase 3. Appendix A details the current membership of the *ad hoc* team.

## Contents

**Section 2** defines the target products and information requirements related to rice crop monitoring. **Section 3** is the work plan for Asia-RiCE Phase 3. Governance is covered in **Section 4**. A conclusion is presented in **Section 5**.

# Rice Crop Monitoring Products & Data Supply

## Target Products and Services

The target crop and agricultural products are summarized in Table 2. It is expected that these products will be generated with national resources as input to crop forecasting systems. These products will be harmonized with the Essential Agriculture Variables (EAVs) which will be developed in GEOGLAM (mentioned in Activity 2-3).

|  |  |  |
| --- | --- | --- |
| ID | Product/Information | Description |
| P1 | Rice Planted/Harvested Area and Mapping | Cultivated area (every cropping season); planted area progress (every month) during the growing season. |
| P2 | Crop Calendars/Crop Growth | Timing of sowing, planting, growing and harvesting; growth status (phenological stage if possible). |
| P3 | Crop Damage Assessment | Detection of flooding and other disaster impacted areas; agro-meteorology; detection of areas impacted by drought or saline water intrusion; detection of pest and disease infestation. |
| P4 | Agro-meteorological Information  | Agro-meteorology anomaly (e.g. precipitation, solar radiation and max/min temperature); crop growth anomaly for early warning, growth outlook, and impact on future yield.  |
| P5 | Yield/Production Estimation\* and Forecasting  | Empirical-statistical model estimates; crop-growth simulation model estimates. |

Table 2 – Target Rice Crop Products (\* required by AMIS)

## Satellite Data Sources

There are a wide variety of satellite data sources required for the generation of these products. Asian rice crop monitoring is heavily dependent on SAR, driven by unique Asian conditions (i.e., rain, consistent cloud cover) as well as the unique signal response characteristics of rice which facilitates growth stage analysis. A set of instruments of interest, along with some example missions, are listed below.

*Please note: data policies differ between missions. For example Aqua, Terra, Landsat, and Sentinel data are free and open; a certain amount of additional SAR data are available for free for R&D purposes, regional initiatives, or under MoUs such as for the Joint Experiment for Crop Assessment and Monitoring (JECAM) (for RADARSAT-2) and Asian-Pacific Regional Space Agency Forum (APRSAF) Space Applications for Environment (SAFE) or MoU for governmental use (for ALOS). A small number of products must be acquired on a commercial basis (e.g., TerraSAR-X/TanDEM-X).*

|  |  |
| --- | --- |
| Instrument Type | Missions/Instruments of Interest |
| Atmospheric Sounder | NOAA (ATOVS), MetOp, JPSS, Suomi NPP, FY-3 |
| Cloud and Precipitation Radar | CloudSat, GPM (DPR), EarthCARE |
| Optical Imagers, Spectral Radiometer, VIS/IR Radiometer | Aqua/Terra (MODIS), GCOM-C, DMSP, JPSS, Landsat-7/8, MetOp, NOAA AVHRR, PROBA-V, Sentinel-2/3, Venus, VNREDSat-1 |
| Imaging Radars (SAR) | C-Band: RADARSAT-2, RISAT-1, Sentinel-1A/1BL-Band: ALOS-2X-Band: TerraSAR-X/TanDEM-X |
| Passive Microwave Radiometers | GCOM-W (AMSR-2), GPM (GMI), DMSP (SSM/I), Windsat,  |

*Table 3 – List of potentially useful instruments for Asian rice crop monitoring*

# Asia-RiCE Phase 3 Work Plan

## Introduction & Overview

This section describes the work plan of Asia-RiCE Phase 3 (April 2019 – March 2021), which aims to:

* Promote the use of EO data for wall-to-wall rice crop monitoring in cooperation with GEORICE and Asia-RiCE team members and international donors;
* Promote the use of new generation tools for big EO data analysis, such as the Open Data Cube and cloud-based systems with available data sources and tools (such as INAHOR and GEORICE);
* Continue to promote the use of the Open Data Cube in Vietnam, Cambodia, and Chinese Taipei in cooperation with VNSC, GA, ESA/CNES, NSPO, and JAXA;
* Promote outcomes, output applications, research results, and progress at international conferences such as the ESA Living Planet Symposium, IGARSS, ACRS, etc.;
* Continue to promote the generation of rice crop outlooks in Asia using the agro-met information from Japan (JASMIN) and India (MOSDAC).

In addition, to these practical aspects, the following research topics are also priorities:

* Research around creating ARD time series from SAR and optical data for rice crop monitoring using Open Data Cube;
* Rice crop models for yield estimation;
* Methane emission from paddy fields;
* Standardization of field surveys for validation of results at national and regional scales (in cooperation with GEORICE);
* The practicality of potential integration of operational systems such as FASAL (India);
* Capacity building in Asia in cooperation with available training centres such as ASEAN Research and Training Center for Space Technology and Applications (ARTSA), Indian Institute of Remote Sensing **(**IIRS), the Centre for Space Science and Technology Education in Asia Pacific (CSSTEAP).

Phase 3 activities will be conducted in close collaboration with APRSAF SAFE activities. Two new SAFE projects: *Rice Crop Monitoring Using SAR in South East Asia, especially the Mekong Region* (Rice Crop Monitoring), and *Decision-making for Food Security with the Provision of Outlook Information Using Satellite-derived Agrometeorological Information* (Agromet) have been approved in the Space Application Working Group of APRSAF.

The rice crop monitoring project will be implemented together with the GEORice expansion project in 5 Mekong countries, escalating Asia-RiCE team activities to regional scale with data and capacity building resources from Japan, India, Indonesia, and Thailand, and utilizing the outputs and outcomes of the SAFE prototypes and GEOGLAM/Asia-RiCE team activities.

The agromet project will respond promptly to the requirements of bi-monthly agrometeorological information needs, such as land surface temperature, precipitation, etc. using EO satellites (including geostationary) for the ASEAN region and South Asia to develop crop outlook information that assists development of national/regional food security information in a timely manner.

Tables 4 and 5 show brief frameworks for these two projects.

|  |  |
| --- | --- |
| **Component** | **Expected Participants** |
| **Dialogue** | GEOGLAM |
| **Existing Regional Projects**  | Asia-RiCE, GEORICE, Mekong Data Cube |
| **Data Sharing** | SAR and high resolution optical (ALOS-2, Sentinel-1, Sentinel-2, RESOURCESAT, etc.) |
| **Application Sharing** | INAHOR (JAXA), GEORICE software (ESA), VNSC software, BHUVAN (ISRO) |
| **Training / Knowledge Sharing** | ASEAN Training Center (ARTSA)UN CSSTEAPISRO IIRS |

*Table 4 – Framework for Rice Crop Monitoring Using SAR in South East Asia, especially the Mekong Region (Rice Crop Monitoring)*

|  |  |
| --- | --- |
| **Component** | **Expected Participants** |
| **Dialogue** | ASEAN, ESCAP |
| **Existing Regional Projects**  | AFSIS, RESAP |
| **Data Sharing** | Rainfall, Vegetation Index, Land Surface Temperature, Drought Index, Soil MoistureGround Observation Data |
| **Application Sharing** | JASMIN, MOSDAC |
| **Training / Knowledge Sharing** | ASEAN Training Center (ARTSA)UN CSSTEAPISRO IIRS |

*Table 5 – Framework for Decision-making for Food Security with the Provision of Outlook Information Using Satellite-derived Agrometeorological Information (Agromet)*

## Activity Area #1: Towards Operational Use

***Activity 1-1 – Data for Whole Country Rice Crop Monitoring*:** With an initial focus on Vietnam (Mekong River Delta) and Indonesia (the top ten rice producing provinces), Asia-RiCE will work with CEOS and others to ensure the necessary data (preferably ARD), data distribution mechanisms, and ground data collection coordination is available to support whole country rice-planted area and production estimations.

***Activity 1-2 – Data Platforms and Tools:*** Asia-RiCE will work to enhance the utility of the Open Data Cube platform for rice crop monitoring, in cooperation with CEOS, APRSAF SAFE activities, VAST-VNSC, GA, CSIRO, ESA/CNES/CESBIO, NSPO, and JAXA. Priorities will be streamlining ODC data (ARD) distribution and data management for whole-country rice crop monitoring (in particular for SAR and the lower Mekong and Chinese Taipei) and the development/porting of tools and algorithms (e.g., INAHOR, GEORice algorithms).

***Activity 1-3 – Rice Crop Outlooks:*** Continue serving as the focal point for the development of regular Asian rice crop outlooks for the GEOGLAM Crop Monitor and AMIS Market Monitor and continue providing access and updates to the JASMIN agro-meteorological information tool. Agro-met products generated from GCOM-C will be available through JASMIN. This activity will be undertaken in collaboration with the ASEAN Food Security Information System (AFSIS) and the ministries of agriculture in the participating Asian countries.

## Activity Area #2: Standardization of Rice Crop Monitoring

***Activity 2-1 – Cross-Validation of Agriculture and Agro-met Variables:*** Comparison of rice crop masks or agro-meteorological data generated by different datasets or algorithms developed during Phase 2, across the various participating countries. Agro-meteorological products to be validated will include various ECVs/EAVs and drought and rainfall products produced by ISRO/MOSDAC, JAXA/JASMIN, GISTDA, SAFE, and others.

***Activity 2-2 – Asia-RiCE Inputs to the CEOS Analysis Ready Data for Land (CARD4L) Product Family Specifications:*** Undertake a comprehensive review of the CEOS Analysis Ready Data for Land (CARD4L) Product Family Specifications and provide feedback on the edits (if needed) to make CARD4L datasets suitable for operational rice crop monitoring at national scale. The aspects to be covered include primarily geometric and radiometric pre-processing of the images. Geometric rectification including geolocation is needed for the use of *in situ* and multi-source EO data. Relative radiometric calibration is required for classification and mapping, whereas absolute calibration is necessary for detection of anomalies and for the retrieval of biophysical parameters. For optical data, correction of atmospheric and BRDF effects, and for SAR data, reduction of speckle noise or incidence angular effect are the main operations.

***Activity 2-3 – Essential Agriculture Variable (EAV) Definition:*** Coordinate Asia-RiCE inputs to the GEOGLAM effort to define the Essential Agriculture Variables (EAVs), working with national agricultural ministries. Currently proposed Tier 0 and Tier 1 EAVs cover: season crop mask, crop type, biomass, LAI, FAPAR, fCover, NDVI, height, and within season yield forecast, etc. EAVs also cover soil moisture, ET, water use, LST, and crop calendars as supporting variables.

## Activity Area #3: Research and Development

***Activity 3-1 – Data Fusion:*** Investigate methods (including machine learning techniques) for integrating different sources of optical and multi-frequency SAR data/ARD (C/L/X-band) for use in rice crop monitoring (specifically planted area, condition, and phenology studies).

***Activity 3-2 – Yield (Production) Estimations:*** Create a rice crop yield estimation model by integrating satellite data, numerical models (statistical models or crop growth simulation models), and in situ yield/production data (both crop cutting and statistical data).

***Activity 3-3 – Methane Emission Evaluation:*** Investigate options for evaluating methane emissions from Mekong Delta paddy fields (a key source of emissions) using SAR, optical, microwave radiometers and dedicated greenhouse gas missions (e.g., GOSAT-1/2, OCO-2, TROPOMI).

***Activity 3-4 – Dual/Full-Polarimetry with High-Revisit and Spatial Resolution Data Analysis****:* Investigate the benefits of frequently observed full-polarimetric SAR data (e.g., ALOS-2 for a super site every 14-days with dual or full-polarimetry 10m spatial resolution toward ALOS-4 mission) for the improvement of planted area, phenology, and inundation monitoring.

## Activity Area #4: Related Projects

***Activity 4-1 – Asia-Pacific Regional Space Agency Forum (APRSAF) Space Applications for Environment (SAFE) Initiative:*** Support new SAFE projects regarding rice crop monitoring and agro-meteorology.

***Activity 4-2 – GEORice/Sentinel-1 Reference Sites:*** Continue Sentinel-1 reference site collaboration with GEORice, VAST-VNSC, ESA, CNES, JAXA, and local universities; and work with ESA on the possibility of expanding to whole-country Sentinel-1 coverage for Asia-RiCE purposes. Continue working with GEORice to maximise the mutual benefits of the ESA DUE Innovator III programme.

***Activity 4-3 – Establish New Joint Experiment of Crop Assessment and Monitoring (JECAM) Reference Sites for Asia-RiCE:*** At present, paddy rice is present in 3 sites in China and 1 site in Taiwan. There is a preliminary agreement to select the Mekong Delta as a new site, as many rice monitoring projects are taking place in this area.

***Activity 4-4 – CEOS Analysis Ready Data for Land (CARD4L) Pilot:*** Pilot the end-to-end application of CARD4L for rice crop monitoring, from data distribution to final results, and provide feedback to CEOS to show the utility and value of these datasets.

***Activity 4-5 – Outlook Activity:*** Implement outlooks and capacity building in the ASEAN region in collaboration with AFSIS.

***Activity 4-6 – Japan-ASEAN Integration Fund（JAIF）Funded Project:***  Support and improve the monitoring of meteorological information for crop outlooks, such as precipitation, temperature, soil moisture, and vegetation index in the ASEAN region through capacity building using Earth observation satellite products.

## Activity Area #5: Stakeholder Engagement

***Activity 5-1 – Close Communication and Capacity Building with End User Agencies:*** Undertake capacity building efforts in Asia in cooperation with available training centres such as ARTSA, IIRS, CSSTEAP, and in collaboration with existing projects such as APRSAF SAFE, GEORice, etc., and using the Japan ASEAN trust fund (JAIF) for ASEAN projects.

***Activity 5-2 – Continue International Engagement via CEOS for Space Data Coordination:*** Asia-RiCE will continue to engage with key CEOS groups to explore opportunities to supplement regional data sources and ensure that the necessary acquisition capacity is available, using EO satellites of the U.S., Europe, and others, as available. Continue advocating for the production and distribution of ARD.

***Activity 5-3 – Establish Improved Links to Stakeholders and Donor Agencies:*** Asia-RiCE requires strong institutional support to ensure continued activity into the future. Asia-RiCE will seek to establish closer linkages to and support from the World Bank, Asian Development Bank, JICA, AFSIS, ESCAP, Mekong River Commission, APRSAF, and SERVIR Mekong, among others.

# Governance

## Schedule

Asia-RiCE Phase 3 will be implemented between April 2019 and March 2021.

The following related meetings will be held in 2019:

* May: APRSAF SAFE Workshop (Hanoi, Vietnam)
* 14-16 October: CEOS Plenary (Hanoi, Vietnam)
* 25-29 November: APRSAF-25 (TBD, Japan)

## Structure

* Lead: Dr. Shinichi Sobue (JAXA);
* Vice-Leads: Dr. Thuy Le Toan (CESBIO), Dr. Kei Oyoshi (JAXA);
* General Secretariat: Dr. Lal Samarakoon (AIT); and,
* Secretariat: Mr. Matthew Steventon (Symbios for JAXA).

## Responsibilities

The Lead and Vice-Leads have the following responsibilities, which are supported by in-kind agency contributions:

* Coordinate the Asia-RiCE crop team activity as described in this work plan;
* Participate in the GEOGLAM Implementation Team to coordinate and promote Asia-RiCE crop team activities including rice crop growth estimation using SAR and optical data, as well as the monthly rice crop outlooks;
* Participate in the CEOS ad hoc Working Group on GEOGLAM to coordinate Asia-RiCE crop team data and system requirements;
* Coordinate Asia-RiCE face-to-face team meetings; and,
* Coordinate the publication of joint papers, the hosting of conference sessions, and other outreach activities with related organizations.

The General Secretariat and Secretariat have the following responsibilities, also supported by in-kind agency contributions:

* Host Asia-RiCE team teleconferences (chair, minutes, action items, etc.);
* Host and maintain the Asia-RiCE website; and,
* Maintain the Asia-RiCE Work Plan and other documents.

# Conclusion

Asia-RiCE Phases 1 and 2 demonstrated the great utility of the initiative, with substantial amounts of CEOS data flowing from space agencies to in-country agricultural agencies and researchers – an achievement that would not have been possible without the collective efforts of the group and its connections to both GEOGLAM and CEOS. As a result of Asia-RiCE, improved rice production estimates are being generated at national and regional scales – valuable inputs to the GEOGLAM Crop Monitor and AMIS Market Monitor that would not otherwise be present.

Asia-RiCE Phase 3 will expand these efforts by greatly increasing the scope of activities and pursuing new research topics and technologies. The Asia-RiCE Leads thank all partners and data providers for their continued support of the initiative as it enters this new phase.

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# Appendix A – Asia-RiCE Membership

Alice Laborte (IRRI)

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Pham Van Cu (University)

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(\* indicates Leads/Vice-Leads)