

# Asia-RiCE

2019 Implementation Report



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Asia-RiCE has been organised to develop the rice crop estimation and monitoring 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.

This report summarises the activities and achievements of Asia-RiCE in 2019. 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.

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# Introduction

## Background

The Asia-RiCE initiative has been organised to develop the Asian 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.

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 & The Phased Approach

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 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).

### Phase 3 (2019 – 2021)

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).

**Specific details of the work to be undertaken in Phase 3 can be found in the Asia-RiCE Phase 3 Work Plan, which is available at: <http://asia-rice.org>**

### Phase 4 (2021+)

With the emergence of SAFE Evolution, Asia-RiCE will reconsider the role that it plays in this space. Asia-RiCE's connection to GEOGLAM and other international frameworks remains critical, so this will remain a key feature and role for the initiative. Concepts emerging from GEOGLAM such as the Essential Agricultural Variables (EAVs) will require a coordinated response on behalf of the rice monitoring community; this is a key role that Asia-RiCE can play. Other practical efforts will be merged under the banner of the SAFE Evolution Rice Crop Monitoring Project.



*Asia-RiCE has linkages with major international frameworks such as the 2030 Agenda for Sustainable Development (SDGs 1, 2, 3, 6, 10, 13 & 15), the Sendai Framework for Disaster Risk Reduction 2015-2030 (impact of drought and flood on agriculture, JASMIN agro-met system), and the Paris Climate Agreement (paddy field methane).*

UN World Conference on Disaster Risk Reduction 2015 Sendai Japan

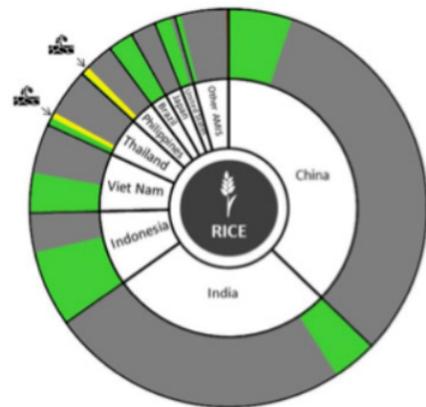
SUSTAINABLE DEVELOPMENT GOALS

PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21-CMP11

# Asia-RiCE in 2019

## Rice Growing Outlooks

Asia-RiCE continued its core work with the ASEAN Food Security Information System (AFSIS) to provide crop condition overview information and outlooks to the GEOGLAM Crop Monitor. GEOGLAM provides monthly crop conditions to AMIS for their Market Monitor.



GEOGLAM Crop Monitor Crop Condition Overview

Example outputs from 2019 can be found on the next page. The Rice Growing Outlook reports can be found online at: <http://www.aptfosis.org/publication/rgo>

## JASMIN

JAXA's Satellite based Monitoring Network system for FAO AMIS Market Monitor (JASMIN) provides satellite-derived agrometeorological information including precipitation, drought index, soil moisture, solar radiation, land surface temperature, and vegetation index. The 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 predefined locations. The outputs assist the ASEAN Food Security Information System (AFSIS) and target country agricultural statistics experts in preparing AMIS outlooks for Asia-RiCE.

## INAHOR-NEO

JAXA/RESTEC also provide the INAHOR (International Asian Harvest mOnitoring system for Rice, crop planted area estimation software) tool to assist AFSIS and target country agricultural statistics experts in preparing AMIS outlooks for Asia-RiCE.

Through an Asian Development Bank Technical Assistance project and SAFE projects under APRSAF, INAHOR (using ALOS-2) has been demonstrated to achieve mapping accuracies of 80-90% for target provinces (in Laos, Thailand, Vietnam (North), Philippines, Myanmar, Cambodia, and Indonesia).

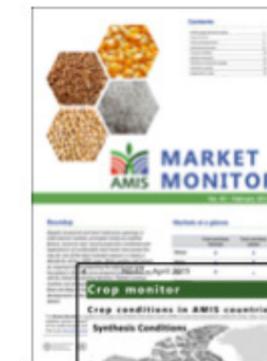
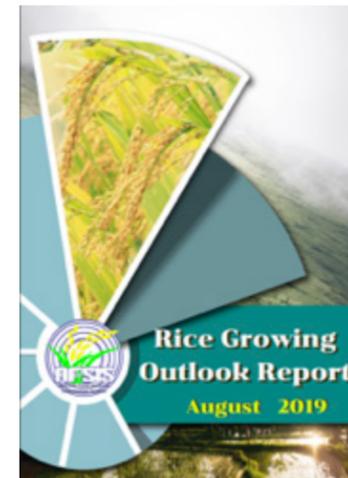
INAHOR-NEO, a machine learning version of the software was developed in 2018. Originally, users would input two threshold values based on field survey results, however with INAHOR-NEO much larger training datasets are used to automatically produce classification models using a machine learning algorithm. Higher accuracies can be achieved with this new version.

## Capacity Building

Asia-RiCE's rice growing outlook capacity building efforts are supported by the Japan-ASEAN Integration Fund (JAIF), which conducts training courses for ASEAN-SCOSA and AFSIS and is developing user guidelines for the use of agromet information from JAXA's JASMIN system – as well as running user surveys to evaluate its effectiveness.

Additionally, in connection to GEOGLAM and CEOS, lectures and training courses have been given by CESBIO on the subject of 'Rice Monitoring Using SAR Data' in connection with:

- CEOS Chair Initiatives Capacity Building: VNCS, Hanoi, February 2019;
- GEOGLAM-ISPRS International Workshop on Earth Observations for Agriculture Monitoring, February 2019;
- LULC Change / Environment and Emissions / South East Asia SARI Workshop, Johor Bahru, Malaysia, July 2019.

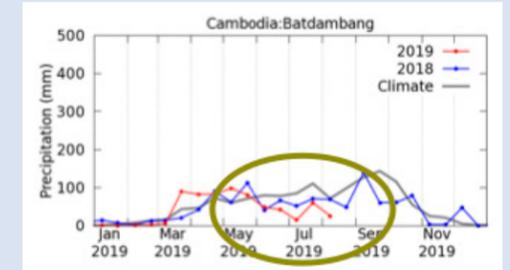


Asia-RiCE outlooks are input to the GEOGLAM Crop Monitor and AMIS Market Monitor.

## Example Rice Growth Outlook Inputs from August 2019

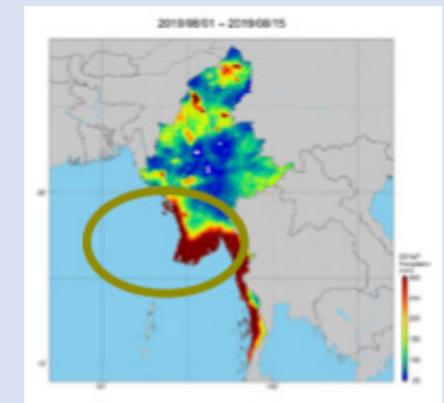
### Cambodia

- Planting of wet season rice reached 86% of the national plan.
- Slower than last year due to rainfall shortages.



### Myanmar

- Monsoon flooding due to heavy rain affected most areas, especially in lower Myanmar (exceeded danger levels on rivers).



# 2019 CEOS Chair Initiative – Rice Map Comparisons

As the 2019 CEOS Chair, the Vietnam Academy of Science and Technology (VAST) Vietnam National Space Center focused on two specific applications utilising Open Data Cube software as their Chair Initiative for the year:

1. Carbon observations, including forested regions;
2. Observations for agriculture.

The focus was on the Mekong basin, a cross-border region strongly affected by climate change and human activities.

A key focus was the practical use of CEOS data, especially SAR for rice crop monitoring in Asia, and to provide a space-based system to support rice monitoring for the countries in the region – linked with VNRice, ESA GEORice, JAXA and GEOGLAM / Asia-RiCE.

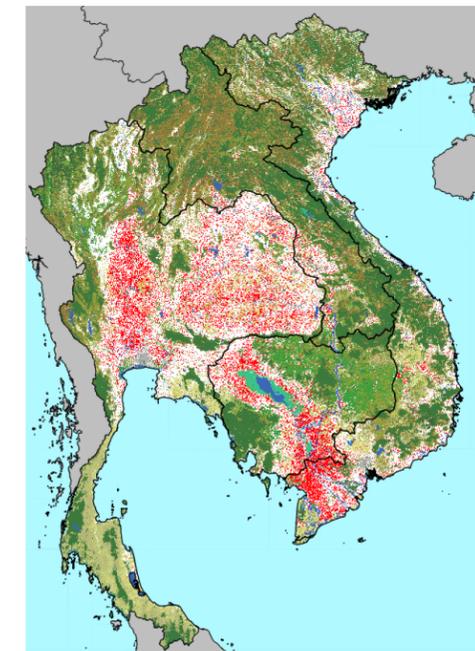
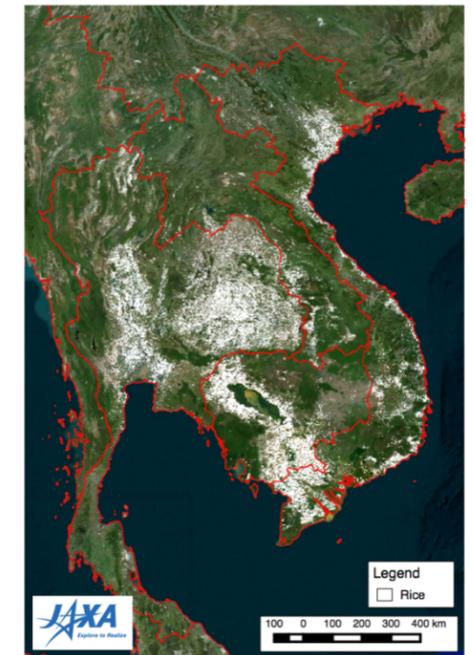
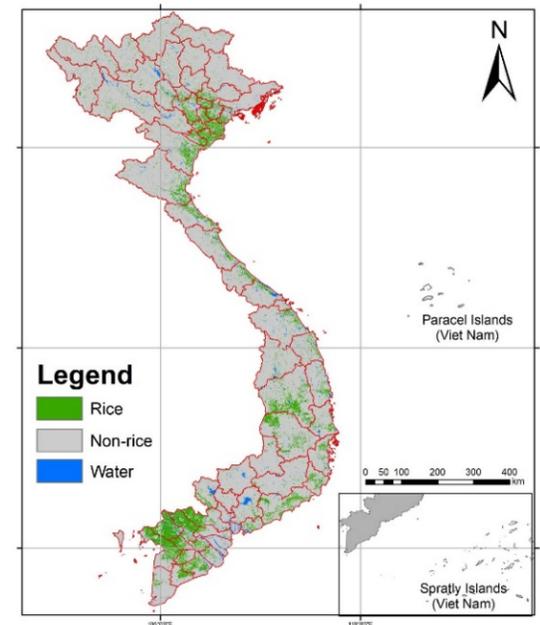
The Vietnam Data Cube contained the following data contributed by CEOS Agencies: Landsat from 1986 to present; ALOS-2 (from JAXA) from November 2016 to present; and, Sentinel-1 (from ESA, processed to Analysis Ready Data by CESBIO/CNES) from October 2014 to present.

In addition to providing data, Asia-RiCE members (VNSC, CNES/CESBIO, and JAXA) also contributed support, methodologies, and products for cross-comparisons (e.g., crop maps and production/yield estimates). An example of a rice map cross-comparison is shown on the next page.

It is expected that the Vietnam Data Cube will continue to be developed, and Asia-RiCE remains a key forum through which the VNSC development team interacts with agencies.

## Achievements

- Rice maps (crop season product) of Vietnam and the Mekong Delta area.
- Rice phenology / growth stage monthly products (for the Mekong Delta and Red River Delta).
- Rice crop production / yield estimation (crop season product) of provinces in the Mekong Delta and Red River Delta.
- Rice maps being evaluated by MARD.
- Continued development of the GEOGLAM National Crop Monitor with NASA Harvest.
- Algorithms developed by VNSC for the Mekong Delta and Red River Delta have been validated using in situ data; now extending to whole country.
- CNES/CESBIO used the Sentinel-1 time series data for different rice ecosystems and tested the ESA GEORICE rice mapping algorithms in 4 countries.
- JAXA analysed the ALOS-2 time series data with JAXA's rice crop monitoring tool INAHOR-NEO (machine learning version) and generated prototype rice crop maps for the 2018 rainy season using available ground observation data and statistical information for 4 countries in cooperation with related organizations.
- In situ data was collected by VNSC for the Red River Delta and Mekong Delta regions to validate the rice maps provided by CNES/CESBIO and JAXA.



Comparison of rice maps of the Mekong region by VNSC (using Sentinel-1, left), JAXA (ALOS-2, right), and CESBIO (Sentinel-1, bottom) in cooperation with countries (space agencies and ministries of agriculture) under APRSAF SAFE and other regional frameworks.



# SAFE Evolution & Rice Crop Monitoring Project

## SAFE Evolution

SAFE Evolution was adopted at the 2017 APRSAF-24 SAFE Workshop. This is a new approach that was proposed to move beyond the SAFE Prototype concept toward multilateral cooperation and knowledge sharing for Asia-Pacific regional environmental issues – making the most of the applications and capabilities developed in the SAFE Prototype phase.

The following were recognised as key factors to take into account in the definition of SAFE Evolution:

- The changing Earth observation (EO) data landscape – in particular with regard to data policies, internet accessibility and solutions, Big Data, and IoT;
- The Global Agendas – United Nations Sustainable Development Goals, Paris Climate Agreement, and Sendai Framework for Disaster Risk Reduction;
- Possibility of collaboration with donor agencies (e.g., ADB, JICA, ASEAN/JAIF);
- Operationalisation of capabilities;
- Other emerging regional activities led by space agencies and international organisations (e.g., regional collaborations of ISRO, ARTSA by GISTDA, RESAP by ESCAP, CEOS Chair initiatives, and ASEAN projects).

The SAFE Evolution Executive Board was convened to finalise the new SAFE Terms of Reference (TOR), and in parallel work began to define two new SAFE Evolution Projects on:

1. Rice Crop Monitoring
2. Agromet Information

Defining a clear path of implementation, performing robust user requirements analyses, ensuring participation of governments for sustainability, and identifying all available resources (data, tools, capacity development opportunities) were recognised as critical to the definition of these projects.

**The Asia-RiCE team will be key contributors to the SAFE Rice Crop Monitoring Project.**

## SAFE Rice Crop Monitoring Project

This project has been established to support agriculture ministries in ASEAN member countries with data, tools, and training to contribute to food security early warning, agricultural statistics, climate change adaptation, crop management, and the monthly rice crop outlook activity for GEOGLAM and AMIS.

Data providers (currently ISRO, GISTDA, and JAXA (regional) and VNSC and LAPAN (in-country)) will work together to compare rice planted area maps and implement improvements, as well as develop shared knowledge around rice crop damage assessments. Other targets will include summaries of growing conditions, crop calendars, and value added information such as forecasts.

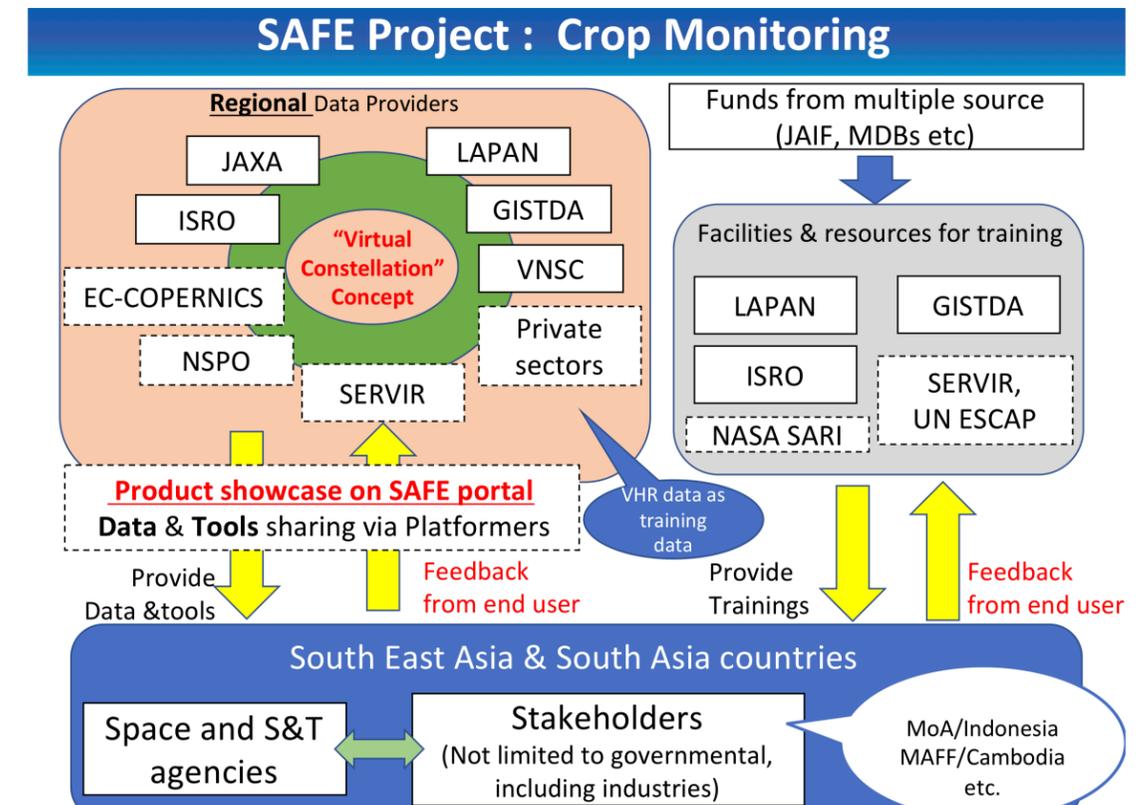
The overall goal is the development of a satellite-based analysis platform which draws upon inputs from all regional data and tool providing agencies and allows end-users in-country to monitor essential statistics related to rice crops, and to assess damage and losses caused by variable disasters in the region.

While the specifics of this project are still being decided, it is intended that the collaborative online platform will be built around a machine learning approach – INAHOR-NEO. INAHOR-NEO will be used to process the numerous sources of data contributed by data supplying agencies into actionable information for users. An archive of historical, regional EO and other data will be established, as this is a necessity for the machine/deep learning software. Approaches for collecting training data efficiently and developing well-calibrated and validated base maps at country/regional scales will be established. It is expected that the machine learning system will draw upon moderate/high resolution radar and optical imagery, training/validation data (e.g., in situ measurements), as well as coarse resolution optical images if necessary, to produce rice planted-area maps at country/regional scale. Expansion to other crop types might be considered in the future.

Capacity building is also a key component of this project, and a programme has been suggested that will:

- Create a user guideline document for rice crop damage assessment (specifically related to floods) using INAHOR-NEO with machine learning technology.

- Outline a standardised training data collection scheme.
- Demonstrate the use of crop damage information for agricultural management.
- Train users on INAHOR-NEO for rice planted area estimation.
- Conduct customised hands-on training courses using the guidelines and the output from INAHOR-NEO for SCOSA and AMAF members.
- Contribute to the GEOGLAM Capacity Building Component.



Planned future multilateral framework of the SAFE Evolution Rice Crop Monitoring Project

# SAFE Evolution Agromet Project

JAXA is working with ISRO, GISTDA and LAPAN on the second of the SAFE Evolution projects – SAFE Evolution Agromet. The SAFE Agromet Project aims to coordinate and improve space-based agrometeorological (agromet) information from various missions and agencies to improve decision-making related to food security in ASEAN member countries. In particular, this will support the monthly rice crop outlook activity (coordinated by the ASEAN Food Security Information System (AFSIS)) that contributes to the GEOGLAM Crop Monitors and the Agricultural Market Information System (AMIS).

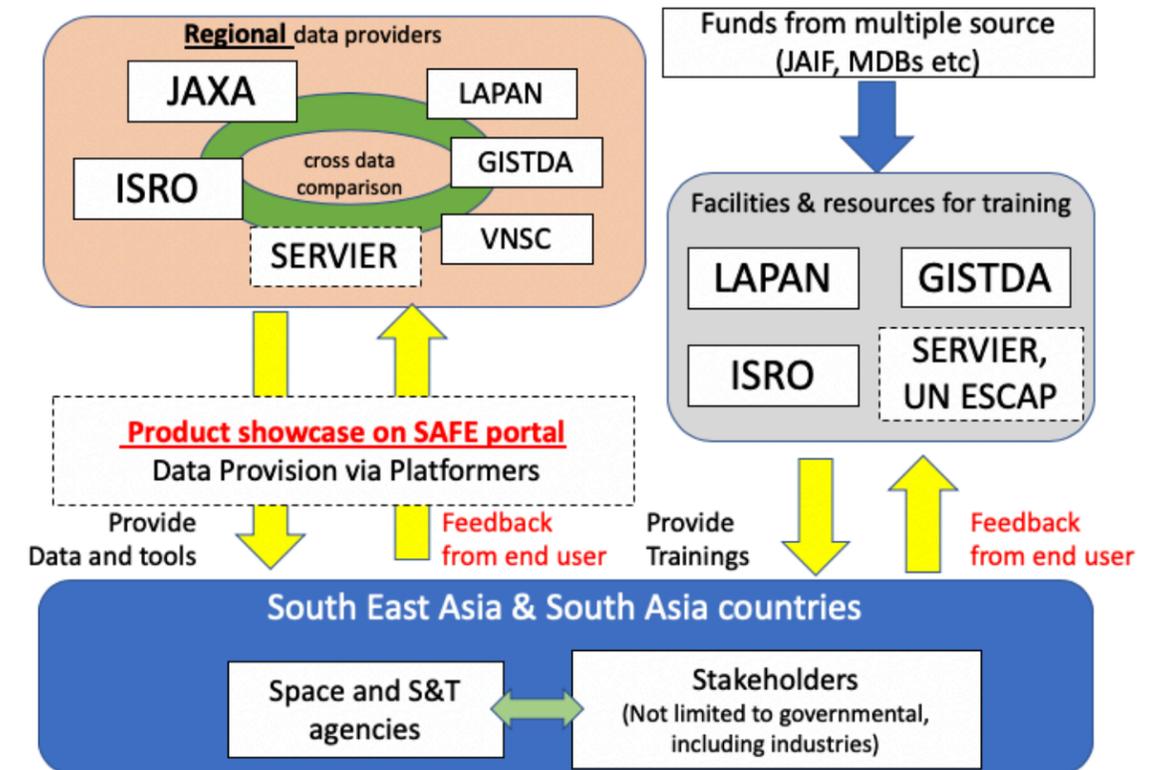
At APRSAF-25, JAXA and ISRO agreed to start a program of work to cross-compare and validate their space-based agromet information (from the JASMIN and MOSDAC & VEDAS systems, respectively) to support rice crop outlooks and to verify the usefulness of the products. Target products include: solar radiance, rainfall, land surface temperature, soil moisture, NDVI, and dryness (drought) index. Trial studies are being conducted for two provinces in India and Thailand, with plans to expand trial areas in the future.

GISTDA have now also joined the multilateral product comparison project – bringing with them products to add to the pool of data available for cross-comparison and validation. The aim is to compare and validate the drought monitoring system of GISTDA using agromet products from JAXA (specifically drought indices: KBDI, DRI). In the near future, NDVI from Himawari-8 and FAO-derived soil-type characteristics will be used to improve KBDI estimates and soil moisture calibration.

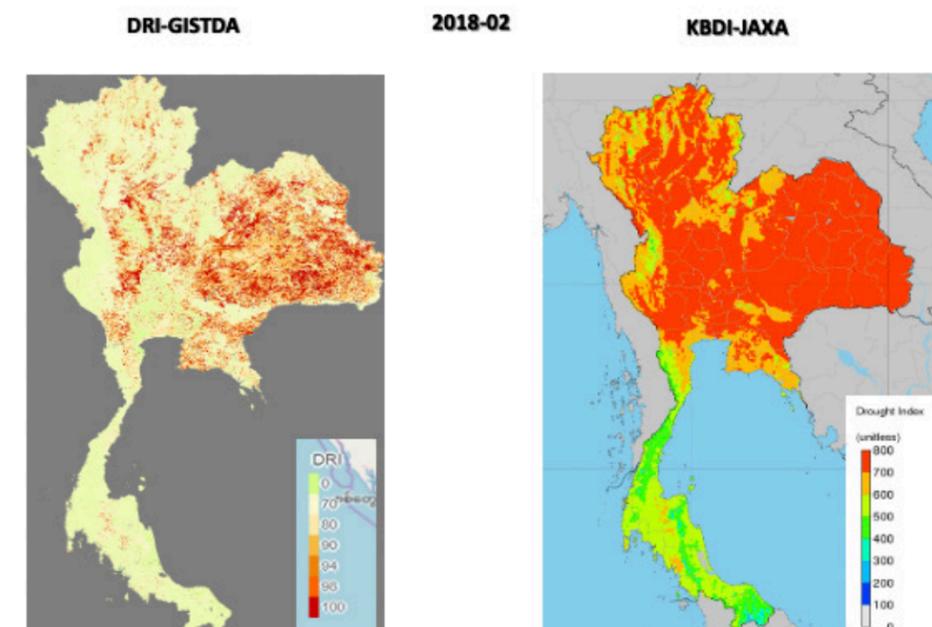
Other expected outcomes are:

- Development of a portal or web page to access satellite-based national agromet information from both ISRO and JAXA systems.
- Knowledge sharing around how to utilise agromet information systems for crop status monitoring.
- Assist national, regional, and global food security analyses by providing local outlook information.
- Contributions to the drought monitoring project in the next Regional Space Applications Program for Sustainable Development (RESAP) conducted by the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP).

## Agromet Project Framework [In future]



Planned future multilateral framework of the SAFE Evolution Agromet Project



Comparison/validation of the drought monitoring systems of GISTDA and JAXA

# Conclusion

## A Critical and Unique Space Agency Service

Asia-RiCE has 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 GEOGLAM and CEOS.

As a result of Asia-RiCE, improved rice production estimates are being generated at national, regional, and global scales – valuable inputs to the GEOGLAM Crop Monitor and AMIS Market Monitor that would not otherwise be present.

Asia-RiCE thanks all CEOS agencies for their unique and critical contributions.

## A New Phase

Asia-RiCE remains an important international voice for the rice monitoring community of Asia, providing a direct link to space agencies via CEOS and to the broader agricultural remote sensing community through GEOGLAM. A strong, coordinated response through Asia-RiCE will be very important in the upcoming effort to define Essential Agricultural Variables.

