Asia-RiCE

2020 Implementation Report

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 2020. 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).

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 2020

Rice Growing Outlooks (RGO)

Asia-RiCE members contribute to the monthly AFSIS Rice Growing Outlooks (RGOs), which support food security by publishing reports covering rice growing conditions and yield prospects, as well as implementing training sessions to enhance the use of space technologies.

The RGOs provide information on rice-growing conditions, indicating whether there are good / poor levels of rice growth, the general trends, and insights into weather damage using satellite-derived agrometeorological information provided by JASMIN.

RGOs also contribute to the Market Monitor published by the Agricultural Market Information System (AMIS) as a component of the GEOGLAM by providing monthly reports on the regional status of rice.

Earth observation satellites periodically provide meteorological information such as precipitation, surface temperature, and solar radiation, which are essential for crop growth. This information is especially important in Southeast Asia, where meteorological disasters such as floods and droughts that affect food security occur frequently. Agricultural statisticians identify abnormal weather that affects crop growth using JASMIN at an early stage, warn of the impact through the RGOs, and forecast final production.

Earth observation satellites provide objective evidence to enhance the reliability of RGO evaluations.

The RGO activity started in 2013 with four countries (Indonesia, Thailand, Philippines and Vietnam) as 'Phase 1' and later expanded to Cambodia, Laos, and Myanmar in 'Phase 2'.

The collaboration between statisticians in national agricultural ministries, AFSIS, and JAXA has effectively integrated agricultural statisticians' experience and expertise with space technology.

http://www.aptfsis.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.

http://suzaku.eorc.jaxa.jp/JASMIN/index.html

Market Monitor by AMIS

The AMIS Market Monitor provides a synopsis of major developments in international commodity markets, focusing on wheat, maize, rice and soybeans. The analysis is a collective assessment of the member organizations of AMIS concerning the international market situation and outlook. Published ten times a year, the report aims at improving market transparency and detecting emerging problems that might warrant the attention of policy makers. Asia-RiCE is a contributor via the RGO activity with AFSIS.

http://www.amis-outlook.org/amis-monitoring

Crop Monitor by GEOGLAM

The Crop Monitors were designed to provide a public good of open, timely, science-driven information on crop conditions in support of market transparency for the G20 Agricultural Market Information System (AMIS). Reflecting an international, multi-source, consensus assessment of crop growing conditions, status, and agro-climatic factors likely to impact global production, focusing on the major producing and trading countries for the four primary crops monitored by AMIS (wheat, maize, rice, and soybeans). The Crop Monitor for AMIS brings together over 40 partners from national, regional (i.e. sub-continental), and global monitoring systems, space agencies, agriculture organizations and universities. Asia-RiCE is a contributor via the RGO activity with AFSIS.

https://cropmonitor.org/

Rice Mapping with Cloud Platform

CEOS Earth Analytics Interoperability Lab

Asia-RiCE has submitted a proposal for the CEOS Earth AnalyticsInteroperability Lab – a platform for CEOS projects to test interoperability in a live EO ecosystem. The Lab will be hosted by the CEOS SEO and jointly operated by WGISS and the SEO to provide:

- Examples of FDA components in active use including new discoverability and access approaches;
- A shared ARD storage and access capability for candidate ARD outcomes and comparative analysis by CEOS teams to support ARD validation;
- Connection to existing and emergent CEOS and Agency services for data discoverability and access; and,
- Collaboration on analytics tools for integrated analysis, including sample data, using Jupyter Notebooks.

The confluence of the CEOS Earth Analytics Interoperability Lab, CEOS Analysis Ready Data for SAR, and the rice crop monitoring community grown via GEOGLAM/Asia-RiCE/APRSAF – and the tools they have developed – provides a unique opportunity to explore how each of these components might be used together in a Future Data Architecture to answer these questions related to interoperability and demonstrate the power of cloud-based, collaborative analysis platforms and associated data.

Specifically, the objectives are to:

- Explore the interoperability of C/L/X-band SAR CEOS Analysis Ready Data for rice crop monitoring.
- Provide feedback on the practical utility of the CARD4L SAR Product Family Specifications (PFS).
- Port tools and scripts developed through GEOGLAM/Asia-RiCE/APRSAF/SAFE for use in the cloud.
- Demonstrate to the rice crop monitoring community the utility and benefits of a cloud-based collaborative working environment. Provide a platform for information and product exchange.
- Put into practice data sharing agreements and mechanisms. Explore means for sharing both satellite and ground truth data and develop standardised practices for product comparison and validation.

INAHOR

JAXA has also developed the INAHOR (INternational Asian Harvest mOnitoring system for Rice, crop planted area estimation software) tool to assist AFSIS and target countries' 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. A machine learning version of the software was developed in 2018. Higher accuracies can be achieved with this new version.

The INAHOR tool and derived rice planted area maps have been used for many projects including the 2020 CEOS Chair Initiative and to improve rice cultivated area statistics in Cambodia (APRSAF/SAFE Rice Mapping Project).

Recognising the benefits of the cloud environment and the ability to reduce the movement and downloading of data, a cloud version of INAHOR-NEO has also been developed.

Capacity Building

The capacity building program of Asia-RiCE and its partners was unfortunately heavily impacted by the COVID-19 pandemic. We are looking forward to future in-person training events taking place as soon as possible.

Remote Sensing of Agriculture and Land Cover / Land Use Change in South / Southeast Asian Countries

Asia-RiCE members contributed to the book entitled *"Remote Sensing of Agriculture and Land Cover / Land Use Changes in South / Southeast Asian Countries"*, which will be published by Springer in 2021.

Three chapters were contributed:

1. Asia-RiCE: Collaborative Framework for Rice Crop Management in Asia;
2. Rice Monitoring Activities with Earth Observation Satellite Data in Southeast Asia;
3. Rice Growth Outlook Using Satellite-Based Information in Southeast Asia.

2020 CEOS Chair Initiative

ISRO, as CEOS Chair for 2020, sought to advance applications related to the SDGs, with a focus on the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) region.

One of these applications was 'Aman' rice planted area mapping over Bangladesh, conducted in cooperation with JAXA.

The objectives were to:

- Demonstrate the application of Analysis Ready Data (ARD) from both ISRO and JAXA satellites;
- Undertake 'Aman' rice mapping at 1:250,000 scale (approximately 50m spatial resolution) for a mutually agreed year (2018); and,
- Validate rice acreage estimates from ISRO and JAXA satellite data and methodologies.

The first input dataset was a 'radar-only' rice-planted area map derived from ALOS-2 ScanSAR from JAXA. The ARD was an ortho-slope corrected, dual polarisation (HH, HV), 50m spatial resolution product. 963 tiles (for each polarisation) were used in total.

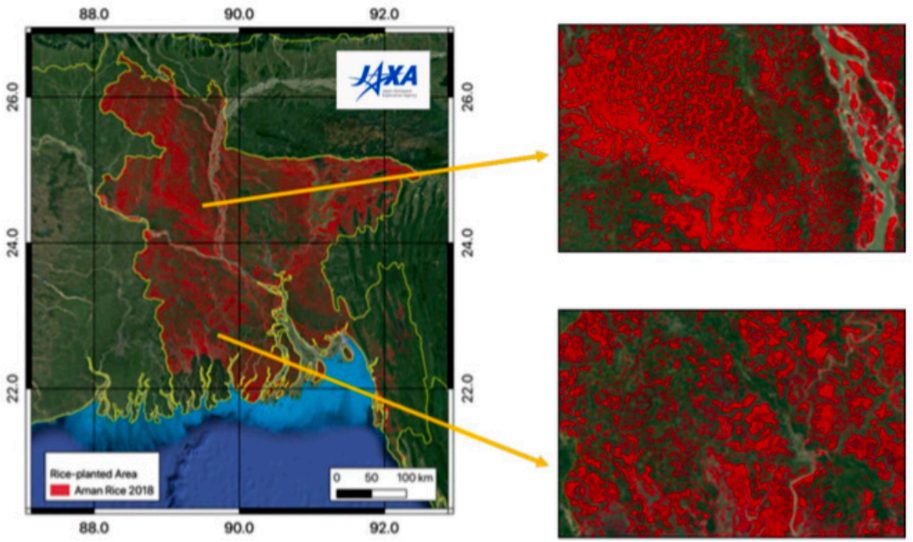
The classification was done via a machine-learning algorithm (random forest), with training/test data from very-high-resolution optical data (5000 samples each for both paddy and non-paddy areas).

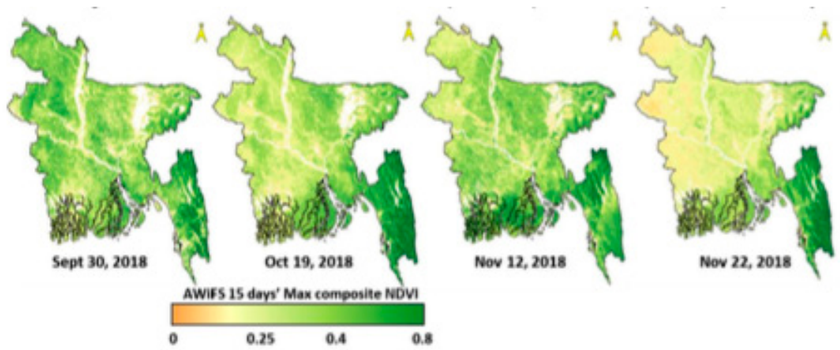
Secondly, high-repeat (5-day) optical data from ISRO's Resourcesat-2 was used to create 56m NDVI composites, which were then compared with past information from RISAT-1 and Radarsat-2 as well as training data from over 287 sites.

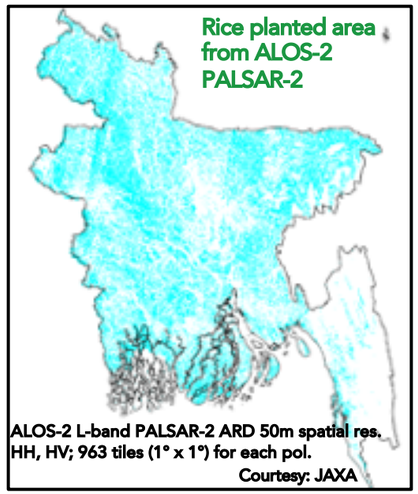
The resulting maps from JAXA and ISRO were then compared.

Conclusions

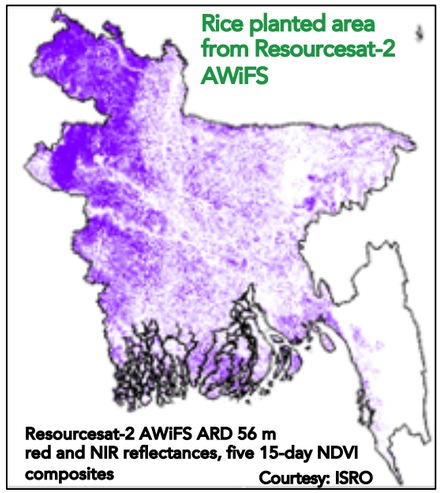
- Combining optical and SAR data resulted in acreage estimates of 'Aman' rice planted area with 95% accuracy, and was found to be better than using one of the data types alone.
- ISRO and JAXA will continue their rice monitoring cooperation for specified regions in India, Thailand and other Asian countries (including the BIMSTEC region) in cooperation with GEOGLAM, Asia-RiCE and the APRSAF SAFE rice crop project.



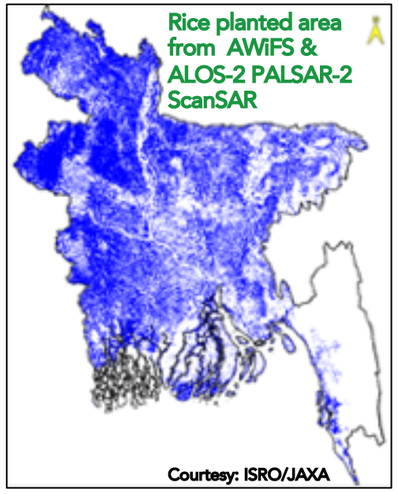




ALOS-2 L-band PALSAR-2 ARD 50m spatial res. HH, HV; 963 tiles (1° x 1°) for each pol.
Courtesy: JAXA



Resourcesat-2 AWiFS ARD 56 m red and NIR reflectances, five 15-day NDVI composites
Courtesy: ISRO



Courtesy: ISRO/JAXA

SAFE Evolution Agromet 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.

Agromet Project Introduction

Project Leader: ISRO

One of the SAFE Evolution projects is focused on Agromet. Approved in 2018, the project seeks to:

- Provide space-based agrometeorological (agromet) information to support the monthly Rice Growing Outlook (RGO) activity of AFSIS (see page 6);
- Conduct comparisons and validations of a variety of space-based agromet information in a multilateral collaboration framework to obtain basic experience in the usage of multi-source data;
- Build a portal site to share knowledge and conduct capacity building for data users.

Team

SAFE Evolution is built around the idea of multilateral projects, and this is the model for the Agromet project. Under the lead of ISRO, GISTDA and JAXA are also contributing to the cross-comparison activity, although a complete multilateral comparison is yet to be undertaken, but JAXA has performed cross-comparisons with both ISRO and GISTDA data.

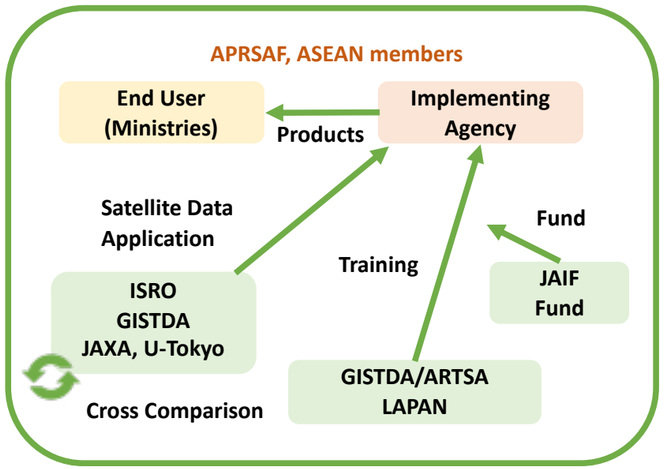
GISTDA/ARTSA and LAPAN, supported by JAIF, will undertake training of implementing agencies,

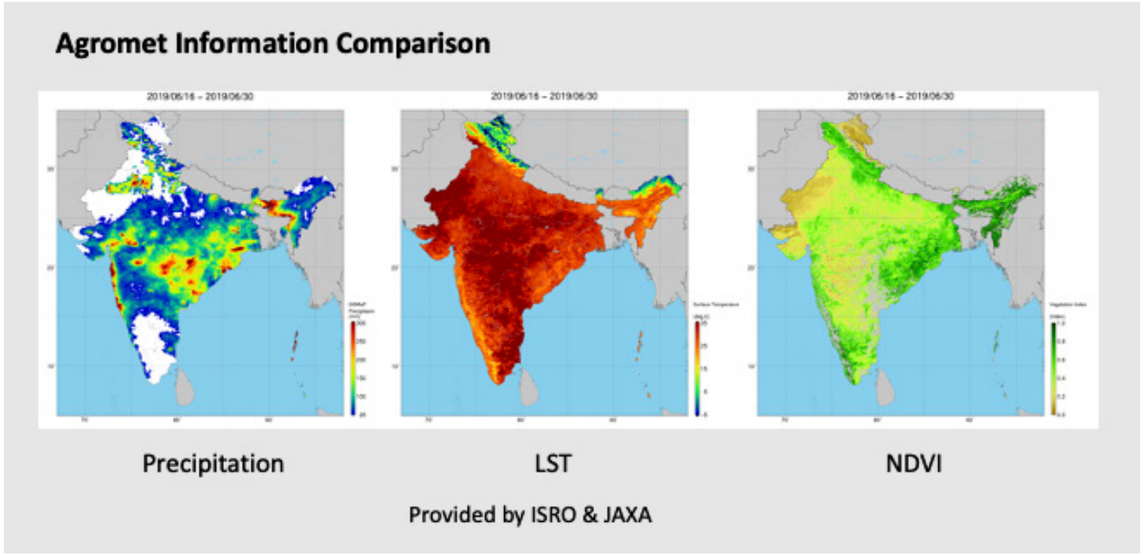
The current framework can be seen in the figure below.

Activities

The following work is currently being undertaken:

- Data comparison between ISRO and JAXA;
- Data comparison between GISTDA and JAXA;
- Application of validated products to Rice Growing Outlooks (RGOs) of AFSIS;
- Contribution to practical usage of data though APRSAF/SAFE website and related services;
- Capacity building and training in data usage (JAIF).





Data Comparisons

ISRO and JAXA

Study Areas: India and Thailand

Results:

- Performance of agromet products (precipitation, NDVI and LST) of JAXA (JASMIN) and ISRO (MOSDAC/VEDAS) for detecting agrometeorological events (drought and flood) were compared in India and Thailand.
- Strong correlation was found between ISRO and JAXA agromet products.
- Both products are able to detect extreme events such as flood and droughts.

GISTDA and JAXA

Study Area: Thailand

Results:

- Agromet products (precipitation and LST) of JAXA (JASMIN) and ISRO (MOSDAC/VEDAS) and GISTDA (GISTDA ground station) were compared.

- GISTDA's ground station LST data and the satellite-derived LST have similar trends, although the absolute values are different.
- Comparison of precipitation data is in progress.

Next Steps

Further intercomparisons will be carried out in 2021, including a possible expansion to other countries and multilateral assessments.

Training planned for FY2020 was postponed due to the COVID-19 pandemic. It is hoped that this thread of the project will re-commence in 2021. Various workshop opportunities also exist throughout 2021.

Products should increasingly feed into the Rice Growing Outlook (RGO) activity of AFSIS and other end-user information products.

SAFE Evolution Rice Crop Monitoring Project

Introduction

Project Leader: GISTDA

The SAFE Evolution Rice Crop Monitoring Project was approved in 2018. Its focus is the use of multiple types of Synthetic Aperture Radar (SAR) data in South East Asia, especially the Mekong Region.

The objectives are to:

1. Produce national agricultural statistics (rice area);
2. Contribute to regional and global food security activities (e.g., the AFSIS Rice Growing Outlooks and FAO AMIS through GEOGLAM and Asia-RiCE.

Implementation Arrangements

Three activity areas make up this project:

1. Cross-comparison and validation: exchanging rice map products and conducting cross-comparisons using bilateral and multilateral frameworks.
2. Data/tool/knowledge sharing and capacity building: Using training facilities (ARTSA, IIRS, etc.); provision of data (ALOS-2, Thaichote, WiFS etc.); sharing of rice mapping software (INAHOR) on the cloud (JAXA); knowledge sharing via the SAFE Virtual Platform (Slack).
3. Dialogue with end users/stakeholders: Rice statistics improvement project in Cambodia (DPS/MAFF, JAXA); ASEAN Food Information system (AFSIS); contributing to international initiatives such as GEOGLAM, CEOS, and SCOSA; dialog with JAIF, ADB, JICA for funding of the project implementation.

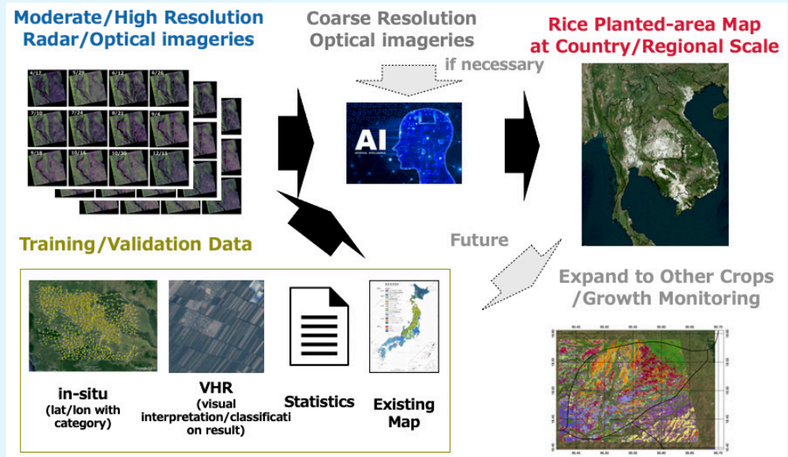
The vision is for a virtual constellation concept, built from a network of closely integrated partners. The current organisational diagram is shown below, and the aspirational scenario is shown at the bottom of page 13.

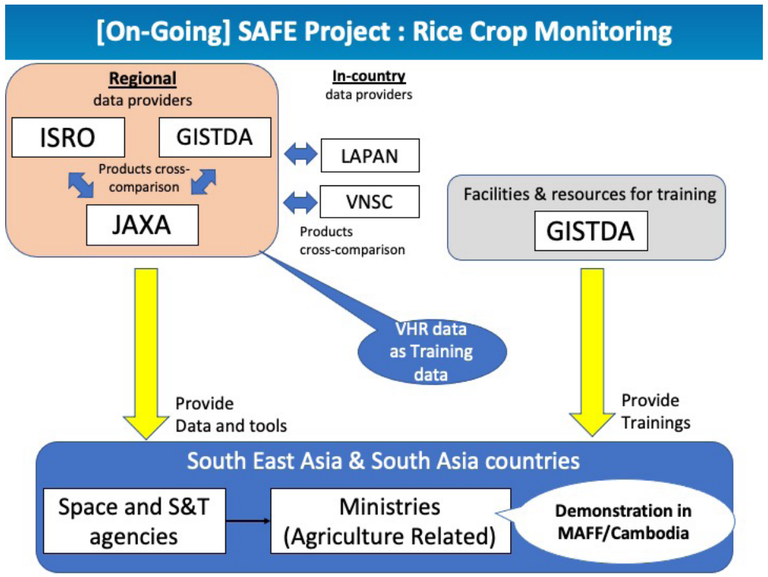
A detailed work plan is currently being developed and commitments from partners are being gathered. GISTDA, ISRO, JAXA, VAST-VNSC and ADPC have all indicated their willingness to participate.

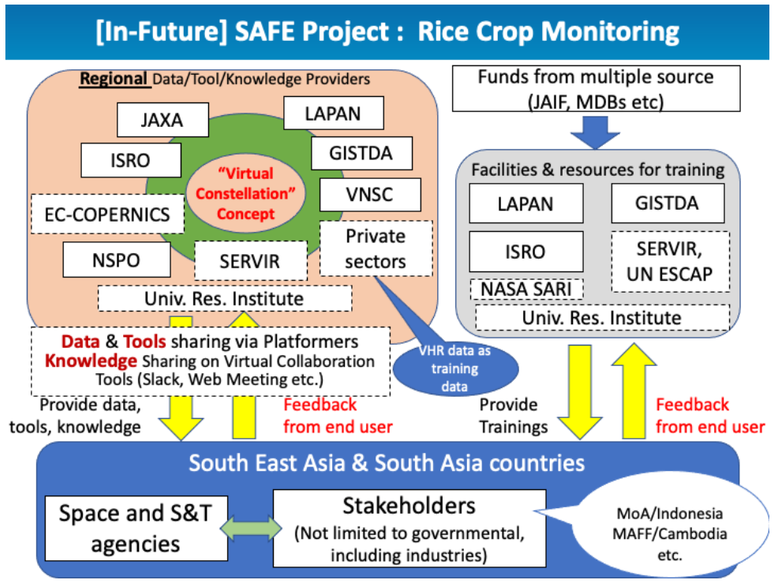
Key Technology: Machine Learning

Research questions:

- Which combination of satellite data, algorithm, training data is best?
- What is the most efficient way to collect training data and how much is needed ?







Validation Framework for Improving Rice Cultivated Area Statistics Using Japanese Space Technology in Cambodia

National agricultural policies are based on statistical data. The Cambodian Department of Planning and Statistics (DPS), Ministry of Agriculture, Forestry, and Fisheries (MAFF) generates national agricultural statistics by aggregating data collected from local offices using a manual reporting system. However, the accuracies of the reported statistics largely depend on the local officer's ability.

A project under the Asia-Pacific Regional Space Agency Forum (APRSAF) / Space Applications For Environment (SAFE) Initiative aimed to develop an evidence-based method for verification (a "Validation Framework") to improve statistical accuracy using satellite-derived rice cultivated areas.

http://www.aptfsis.org/news-events/news50

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.