Asia-RiCE

2022 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 2022. 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.

Asia-RiCE
Crop Estimation and Monitoring

JAXA

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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 national and regional food security, climate change adaptation/mitigation, and also Goal 2 of the SDGs by providing rice-related actionable information for improved decision making.

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

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 (JASMIN) system for FAO AMIS Market Monitor 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 organisations 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 organisations and universities. Asia-RiCE is a contributor via the RGO activity with AFSIS.

https://cropmonitor.org/

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 ISRO 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.

2022 Updates

- ALOS/ScanSAR data has been released as free and open data on Google Earth Engine (GEE).
- Agencies including ISRO, JAXA, GISTDA and VNSC led efforts and activities that were held to utilise satellite data for rice cultivation.
- Efforts were made globally and locally to help countries benefit from geospatial data for rice, such as through organisations like GEOGLAM, IRRI, APRSAF, SAFE, and Asia-Rice.
- There has been a significant increase in the use of cloud platforms for ease of use and application (GEE, VEDAS, and others).
- SAFE endorsed a new project, CH4Rice, focused on evaluating methane emissions from rice paddies and managing water resources, which is being led by VNSC.

In-situ Data Coordination

GEOGLAM In Situ Working Group represented the rice community at GEOWeek 21. Anyone willing to share recent (within 5 years) in-situ data on rice crop extent should contact GEOGLAM. Such in-situ data can be immediately used to improve the WorldCereal crop extent map (input to the GST AFOLU). Work on in-situ data standards were discussed during the AOGEO Task Group (TG)- 5 meeting. EAV standards were also discussed with GEOGLAM.

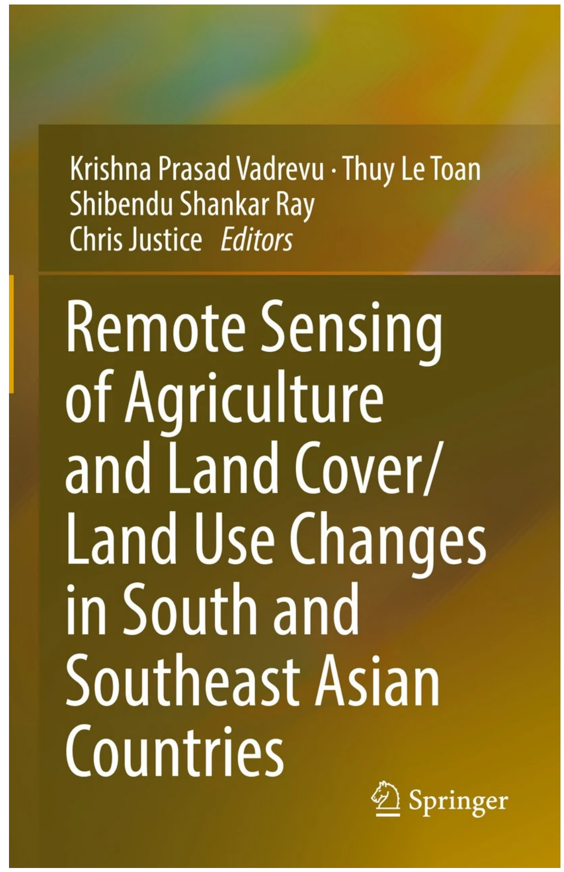
Remote Sensing of Agriculture and Land Cover/Land Use Changes in South/Southeast Asian Countries

Asia-Rice members contributed to the book entitled *"Remote Sensing of Agriculture and Land Cover/Land Use Changes in South/Southeast Asian Countries"* which has been published by Springer in 2022.

Editors: Krishna Prasad Vadrevu (USA), Thuy Le Toan (France), Shibendu Ray (India) and Chris Justice (USA)

The three chapters that Asia-RiCE members contributed to were:

- Asia-RiCE Activities Overview (including SAFE)
- Rice monitoring activities with Earth Observation Satellite data in Southeast Asia (Cambodia, Indonesia, Thailand, Vietnam, etc.)
- Rice Growing Outlook using satellite-based agrometeorological data in Southeast Asia.



Coverpage of the book published in Springer

Springer link: https://link.springer.com/book/10.1007/978-3-030-92365-5

Future Work

- Continue capacity building by using available international donor funds.
- Continue the support of satellite data utilisation using various available platforms such as VEDAS, ODC, GEE, TELLUS, etc to contribute to regional issues.
- Extend the results of SAFE Rice Crop monitoring projects to other countries/regions, through multilateral cooperation and joint efforts of other initiatives like UN-ESCAP.
- Promotion of SAFE Agromet project across regions such as South Asia, and also expanding users towards commercial companies (from the current governmental base).

SAFE Project

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.

SAFE Rice Crop Monitoring Project

Introduction

Project Leader: GISTDA

The SAFE Evolution Rice Crop Monitoring Project was approved in 2018 with the aim to provide regional scale, high-quality, space-based rice crop maps. Its focus is using multiple types of Synthetic Aperture Radar (SAR) data in South East Asia, especially in the Mekong Region.

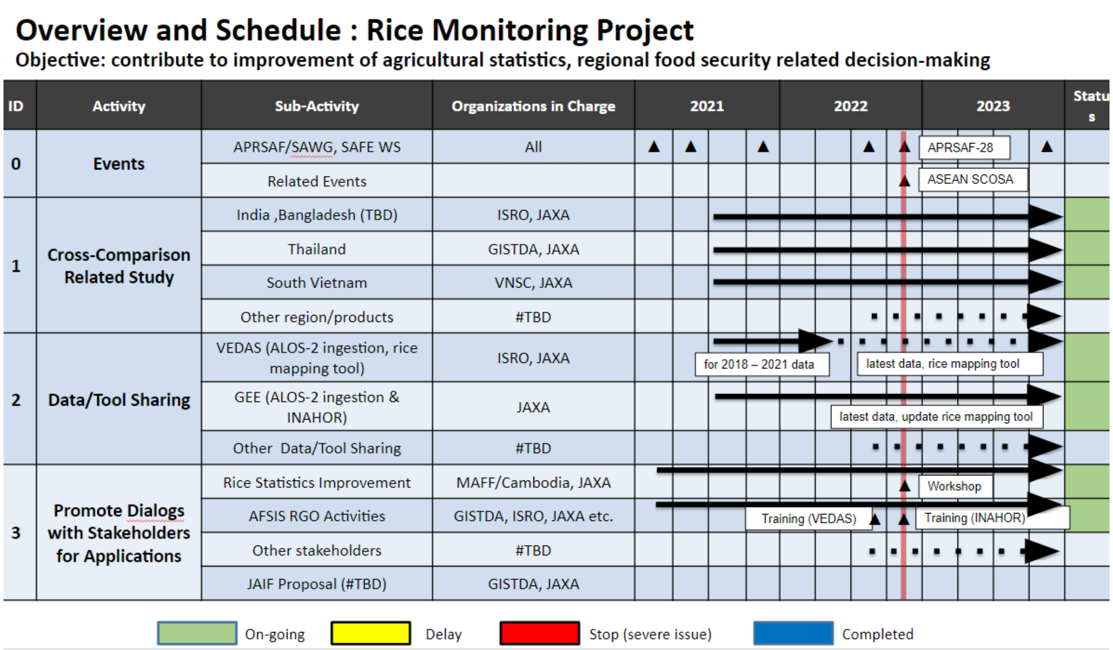
The objectives are to :

- Produce national agricultural statistics (rice area) and support decision making in agricultural policy;
- Contribute to regional and global food security activities (e.g., the AFSIS Rice Growing Outlooks and FAO AMIS through GEOGLAM as Asia-Rice, AOGEO etc.)

Implementation

Three main ongoing activities under this project include:

1. Cross-comparison and validation: Exchanging rice map products and conduct cross-comparisons for algorithm improvement using bilateral and multilateral frameworks mainly in India, Thailand and Vietnam by national space agencies; other areas for further expansion of studies are also being identified.
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 (developed by JAXA); knowledge sharing via the SAFE Virtual Platform (Slack); using data analysis platforms (VEDAS, GEE, ODC, etc.)
3. Promote 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, VNSC/ISRO, and SCOSA; dialogue with JAIF, ADB, JICA for funding of the project implementation.



SAFE Rice Monitoring Project Schedule

Next Steps

- Continue to implement and expand the ongoing cross-comparison-related studies to other regions and countries.
- Continue to facilitate data and tool sharing on data platforms such as ingesting the latest ALOS-2 data into VEDAS and GEE, and update the rice mapping algorithm based on the results of cross-comparison related studies.
- Further collaboration and continuous dialogue with stakeholders for practical use. Continue coordination with AFSIS, MAFF/Japan, MAFF/Cambodia etc.)

Cross Comparison Related Study in India

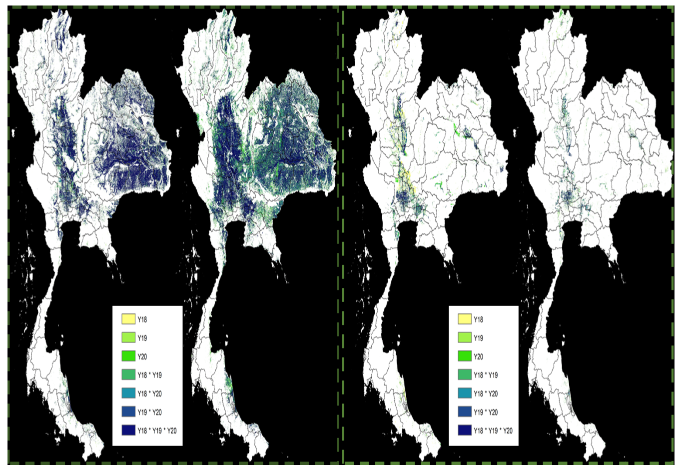
A rice mapping algorithm comparison and development study was conducted using shared ALOS-2 ScanSAR data for test sites in India. Three methods were evaluated, including Random Forest (RF), Random Forest with automatic Hyperparameter Optimization, and Decision Tree (DT). The best performance was achieved by the Random Forest with automatic Hyperparameter Optimisation method. The study also tested transfer learning and found that the algorithm is more efficient when trained with well distributed and balanced ground truth data.

The next step is to expand the study to other regions and seasons, assess and compare the efficacy of C-band SAR from RISAT-1A, Sentinel-1 and ALOS-2 PALSAR-2, and all SAR combinations to improve the algorithm further. Some results are shown below:

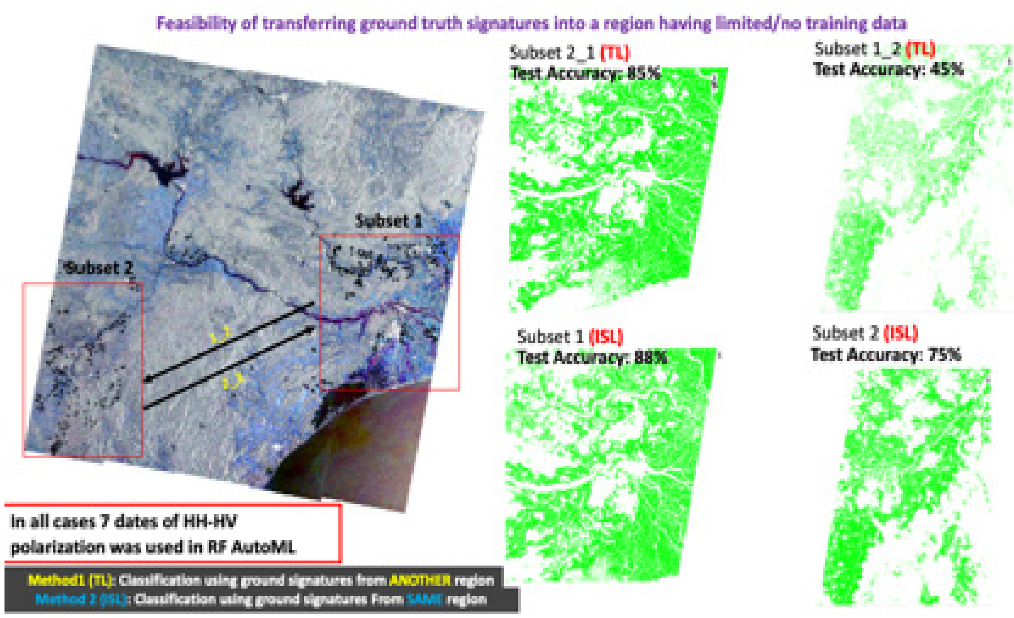
Cross Comparison Related Study in Thailand

The rice maps derived from GISTDA (Landsat 8 and Sentinel-2 based map) and JAXA (ALOS-2 based map) were compared, and cropping pattern changed areas were identified from both maps. The plan is to investigate the factors that contributed to these changes.

Some results are shown below:



Comparison of GISTDA and JAXA's Ricemap Products in Thailand



Paddy planted area feasibility analysis

SAFE Agromet Project

Introduction

Project Leader: ISRO

The Agromet project was approved in 2018 with the aim to:

- Provide space-based agrometeorological (agromet) information to support the monthly Rice Growing Outlook (RGO) activity of AFSIS (see page);
- 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, JAXA has performed cross comparisons with both ISRO and GISTDA data.

GISTDA/ARTSA and LAPAN, supported by Japan-ASEAN Integration Fund (JAIF), will undertake training of implementing agencies.

The current framework can be seen in the figure below.

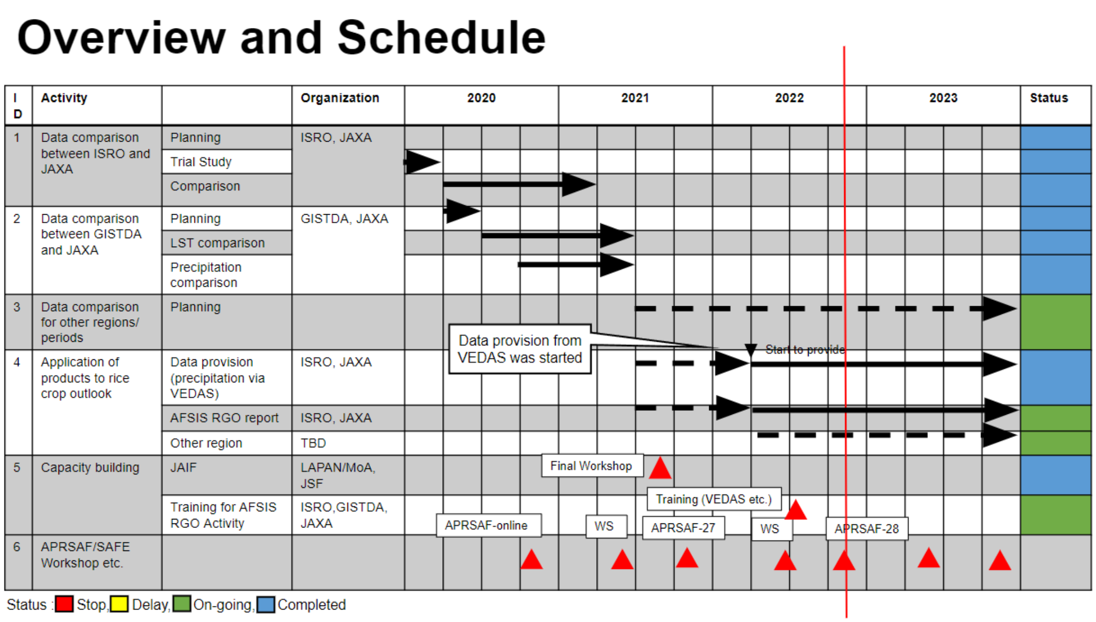
Activities

The following activities have been completed:

- Satellite derived agromet data comparison between ISRO and JAXA with GISTDA's in-situ data;
- Application of validated products to Rice Growing Outlooks (RGOs) of AFSIS;
- Contribution to practical usage of data through APRSAF/SAFE website and related services;
- Capacity building and training of data usage provided to Agricultural Statisticians in the ASEAN region funded by the Japan-ASEAN Integration Fund (JAIF).

Data Comparisons

As a result of past year's data comparison studies, ISRO data (precipitation over a wide area) is now being used in the monthly ASEAN rice crop report published by AFSIS (ASEAN Food Security Information System).



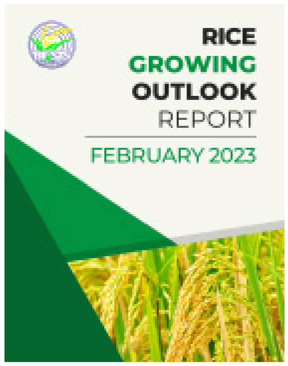
Timeline of SAFE Agromet Project

A trilateral meeting was held between AFSIS, ISRO, GISTDA and JAXA to discuss future collaboration.

ISRO's precipitation data provision system was developed and open to public. The data are utilised to generate monthly AFSIS's RGO report by agricultural statisticians in ASEAN countries.

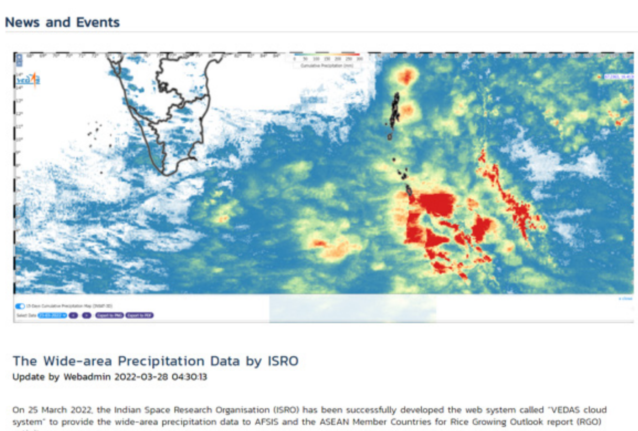
The RGO reports are availalbe here:

https://aptfsis.org/publication/rgo



ISRO conducted a training program on "Satellite Derived Agrometeorological Data for AFSIS's Rice Growing Outlook (RGO)" using ISRO's VEDAS system under ISRO, JAXA and GISTDA partnership was held on 11 July 2022.

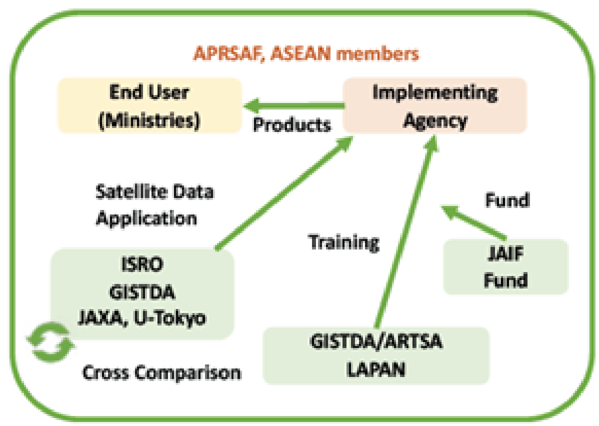
ISRO demonstrated the Meteorological & Oceanographic Satellite Data Archival Centre (MOSDAC) / Visualisation of Earth Observation Data and Archival System (VEDAS) system and provided training sessions on using the VEDAS platform. The event was attended by twenty six statisticians from eight ASEAN countries, including Vietnam, Cambodia, the Philippines, Indonesia, Thailand, and Malaysia, and was deemed a great success. Trainees have learned about the use of Indian Satellite derived agrometeorological information through the MOSDAC and VEDAS systems to improve the capabilities of satellite based products to solve the common problems in agricultural information systems.



Wide Area Precipitation Data by ISRO

Future Plan

- Conduct cross-comparison and validation with in-situ data (LST etc.) over longer time periods and additional geographical locations to further validate with the request and support from participating agencies.
- Explore potential benefits of VEDAS platform to end-users; identify and create information in user friendly formats and user-ready information (csv, png, etc.)
- Organise more training and capacity building programs to further promote the satellite based agromet data utilisation via a platform (e.g. VEDAS etc.) in collaboration with AFSIS.
- Continue the dialogue with AFSIS and ASEAN countries.
- Disseminate project results, and promote agromet data for crop outlooks in other regions such as South Asia (e.g. Sri Lanka, Bangladesh, etc) using cooperation with AFSIS as a success story.



SAFE Evolution Members

SAFE CH4Rice Project

Introduction

Project Leader: VNSC

“Assessment of Methane Emission from Rice Paddies and Water Management” also known as CH4Rice is a new multilateral SAFE project endorsed at APRSAF-28 in November 2022.

Background

Methane (CH4) is 30 times stronger than carbon dioxide as an absorber of infrared radiation. Reducing CH4 emissions would be an effective option for rapid climate change mitigation, particularly on a decadal timescale. According to the Intergovernmental Panel on Climate Change (IPCC), atmospheric CH4 has been growing in concentration since 2007, which is largely driven by emissions from fossil fuels and agriculture.

CH4 emissions from rice paddies are estimated to be about 8% of total global anthropogenic methane emissions. CH4 emissions from rice paddies can vary depending on the number and duration of crops grown, water regimes, soil type, temperature, and rice cultivar. Methods such as Alternate Wetting and Drying (AWD) have been found to be effective in reducing methane emissions.

Objectives

An accurate assessment of CH4 emissions is necessary for achieving sustainable rice cultivation. Hence, the CH4Rice project aims to:

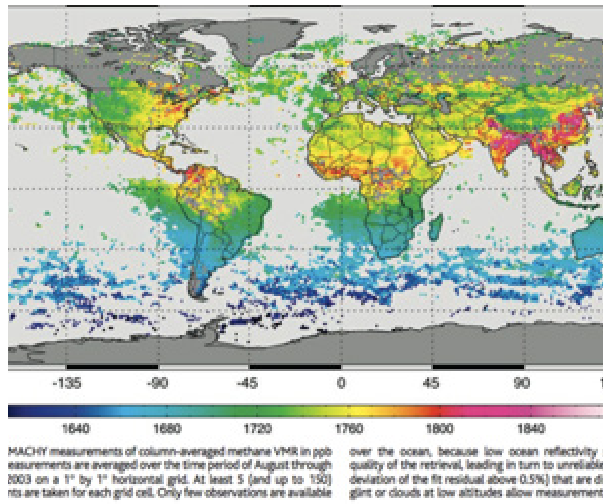
Implement CH4 Monitoring, Reporting and Verification (MRV) using satellite and in-situ data.

Manage water efficiently through irrigation methods that result in lower CH4 emissions, such as AWD.

Promote and participate in regional and global sustainable agriculture related initiatives, such as SDG 2, GEOGLAM/Asia-RiCE and AOGEO.

Implementation Activities

- The following activities are being planned:
- Development of methodology to estimate CH4 emissions from rice paddies
- Data, tool and knowledge sharing and capacity building for multilateral collaborations
- Promote dialog with stakeholders and end-users by presenting results
- Synergies with SAFE Agromet and Rice Monitoring projects



Atmospheric CH4 Concentration (measured by SCIAMACHY)

Development of Methodology to Estimate CH4 Emissions from Rice Paddies

The proposed methodology for CH4 emission estimation from rice paddies will focus on using the bottom-up approaches, as outlined by the IPCC in 2006. CH4 emission factors are multiplied by the cultivation period and harvested area to provide a final estimate. Note that using the Tier 1 method does not take into account country-specific emission factors. This will involve the disaggregation of the annual harvest area of rice for at least three baseline water regimes including irrigated, rainfed, and upland. Meanwhile, the Tier 2 method takes into account country-specific emission factors. This will involve the same steps as the Tier 1 method, but using country-specific emission factors.

Data, Tool and Knowledge Sharing and Capacity Building for Multilateral Collaborations

- The following activities are being planned:
- Assessing the entire region by gathering results from each country/region.
- Sharing satellite data, such as ALOS-2 (both full-pol and ScanSAR dual), NISAR, etc.

- Sharing methodology and tools on platforms such as ISRO's VEDAS (Visualisation of Earth Observation Data and Archival System), Google Earth Engine (GEE), Open Data Cube (ODC), and creating tutorial materials.

Promoting Dialogue with Stakeholders and End-users by Presenting Results

Planned activities include:

- Taking into account national policy and attempting to connect with relevant agencies, such as agriculture, environmental, and water management-related ministries in each country.
- Contributing to international initiatives like the Asia-RiCE/ GEOGLAM, CEOS, AO-GEO and ASEAN SCOSA.
- Engaging in dialogue with organisations such as the Japan International Cooperation Agency (JICA), the Asian Development Bank (ADB), and the Japan International Agriculture Fund (JAIF).
- Building collaborations with international initiatives related to CH4 emissions, such as UNEP and the International Methane Emissions Observatory (IMEO).

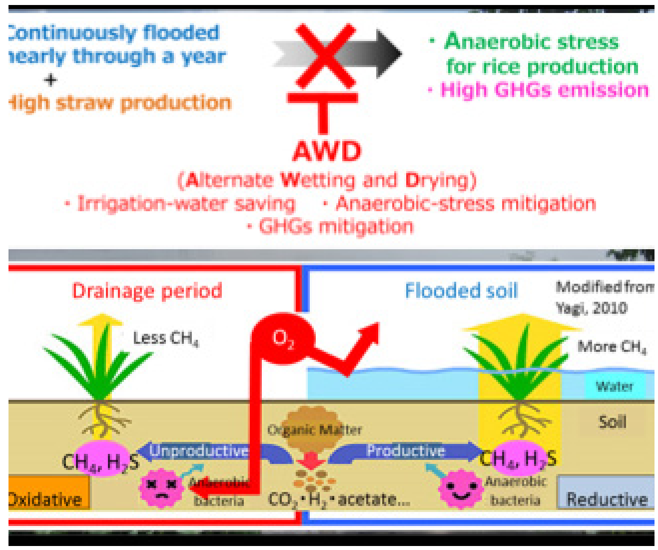
Synergies with SAFE Agromet and Rice Monitoring Projects

Synergies with SAFE Agromet and Rice Monitoring Projects are imperative to optimise the use of resources and obtain mutual benefits. Existing bilateral activities and collaborations will prove to be valuable. Improved rice area maps from the Rice Crop Project will increase the accuracy of methane emission estimations.

Future Plan

Prepare work plan including implementation framework, schedule of the project

Identify and select study areas for ALOS-2 full-pol observations (super sites)



Alternate Wetting and Drying Process

Current and Future Sites

Data/Tool Sharing: VEDAS

ISRO's Visualisation of Earth Observation Data and Archival System (VEDAS) is a repository that provides easy access to satellite data. Through VEDAS, spatio-temporal analysis can easily be done, such as data visualisation, analysis like multi-temporal profiling, multi-temporal analysis, feature classification, image composites, etc. VEDAS has a simple land cover classification algorithm (thresholding method).

ISRO's precipitation data provision system was developed and can be openly accessed through VEDAS. The data are utilised to generate monthly AFSIS's RGO report by agricultural statisticians in ASEAN. Site Link: https://vedas.sac.gov.in/AFSIS/

JAXA has shared ALOS-2 ScanSAR data for the period 2018 -2022 for the Asian region through the VEDAS system, including more than 1,000 scenes covering parts of India, Sri Lanka and Thailand.

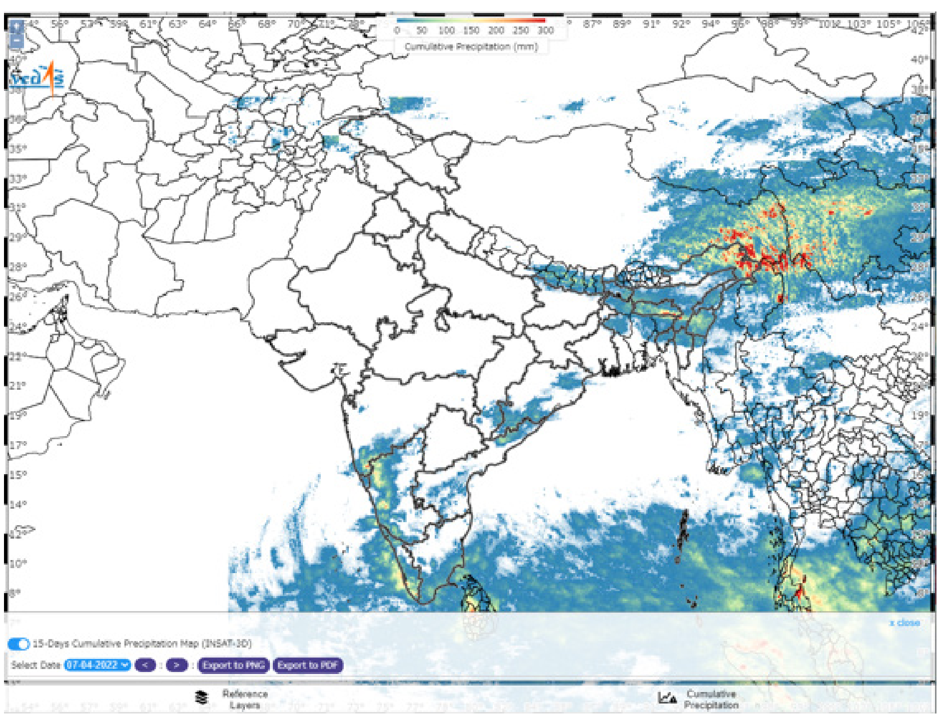
Site Link:

https://vedas.sac.gov.in/vegetation-monitoring/index.html

VEDAS scripting environment will be available in the near future. Also, in future, if near-real time data is available in VEDAS, it can be used for Rice crop monitoring and other disaster-related applications.

The team is working on expanding the platform to host user defined algorithms such as INAHOR (developed by JAXA), or other shared algorithms (such as drought indices) from collaborating agencies, which will allow users to carry out analysis remotely through the VEDAS system.

https://vedas.sac.gov.in/en/

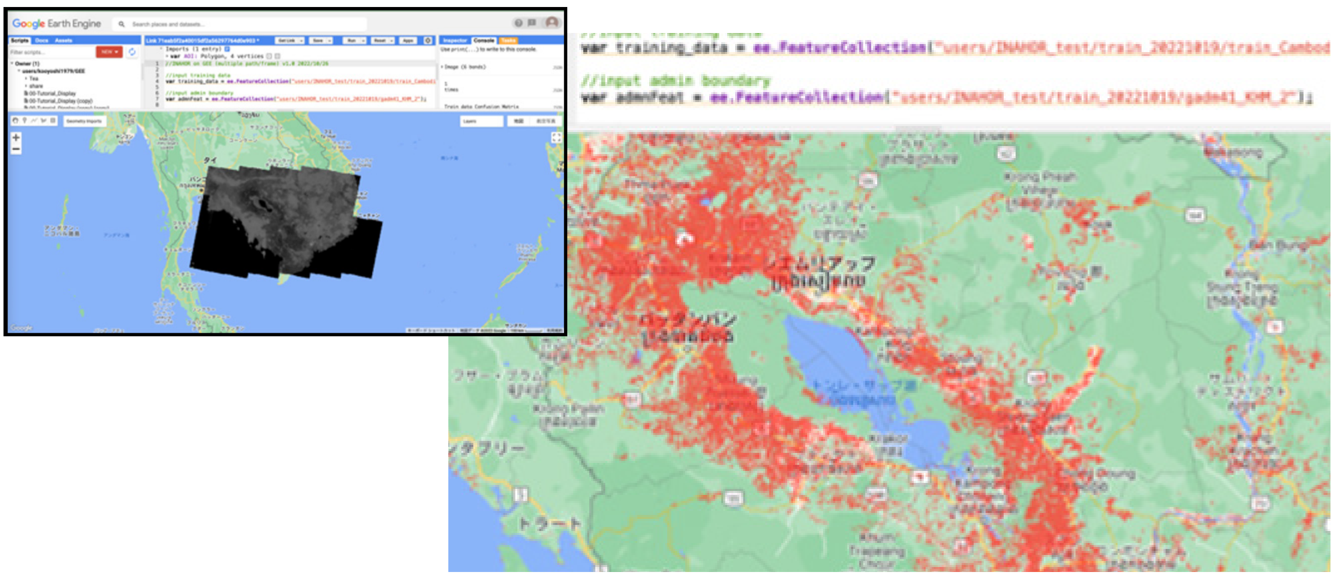


Precipitation data for AFSIS 's RGO on VEDAS

Data/Tool Sharing: Google Earth Engine with ALOS-2

ALOS-2 ScanSAR L2.2 data, which has been ortho-slope corrected, has been ingested into Google Earth Engine (GEE) as open access data to aid rice monitoring in the Asian region. Tutorial materials are also available to help agricultural statisticians, who may need to gain remote sensing expertise to use the data.

ALOS-2 ScanSAR L2.2 (ortho-slope corrected data) has been released as Open and Free data, which can be downloaded from https://www.eorc.jaxa.jp/ALOS/jp/dataset/palsar2_l22_e.htm



Rice area identified by Random Forest using ALOS-2 HH and HV time-series metrics (min/max/mean)

Taiwan Data Cube

Data Cube platforms have been continuously promoted by the Committee of Earth Observation Satellites (CEOS) for sharing of remote sensing data. The major objectives are

- Integration of multi-temporal and multi-sensor remote sensing datasets through data warehousing.
- Share Analysis Ready Data (ARD) with precise pre-processing and standardisation
- Improve applicability by providing data through the concept of a service provider.

The service framework of Taiwan Data Cube includes the acquisition of multisensor data, preparation of ARD, extraction of phonological information, and analysis of hyper-dimensional data.

Integration of TWDC and Taiwan Computing Cloud (TWCC) helps in accomplishing multiple cubes data sharing framework. Data is stored in different cubes according to sensor types or source providers. Users can access data of various cubes when authorisation is granted.

NSPO NARLabs 國家實驗研究院 國家太空中心 National Space Organization

Taiwan Data Cube

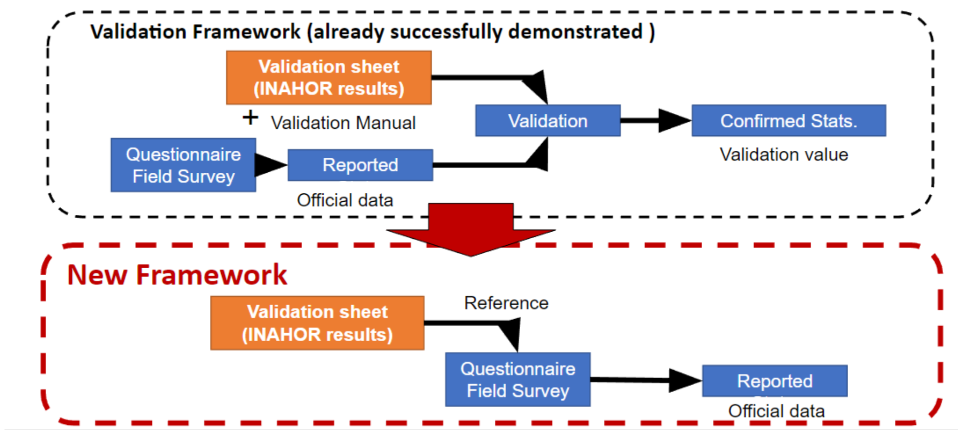
Validation of Rice Statistics Improvement Project in Cambodia

Implemented by Cambodia MAFF and JAXA

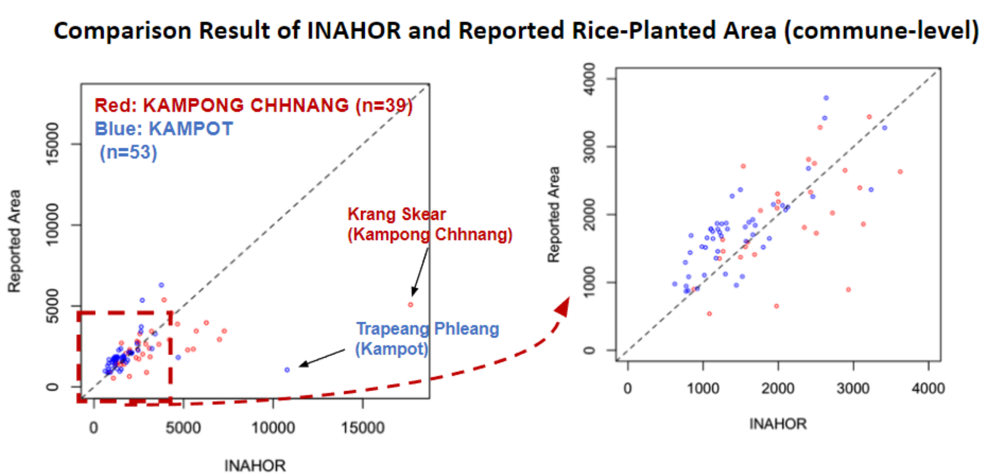
The SAFE initiative aimed to develop an evidence based validation framework to improve the statistical accuracy using satellite derived rice cultivated areas in Cambodia. In 2021, the demonstration for two target provinces (Kampong Chhnang and Kampot) was conducted, and some communes showed a significant difference. The validation framework was not conducted due to COVID-19 pandemic.

Local officials used a "Validation Sheet" as a reference source when compiling reported statistics, but it was not utilised for validation purposes. Workshops with these officials took place in December 2022 in the provinces of Battambang, Kampong Chhnang, and Prey Veng.

The project results were shared in AFSIS website: http://www.aptfsis.org/news-events/news50, ASIA-Rice Report 2021 and on Remote Sensing of Agriculture and Land Cover/ Land Use Changes in South and South east Asian Countries academic publication.



Demonstrated Validation Framework



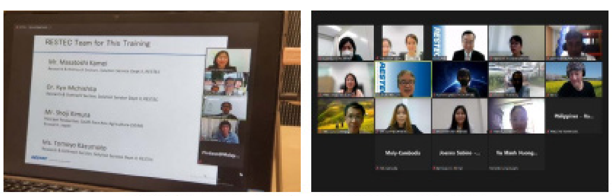
INAHOR and Reported Rice-Planted Area Comparison

Outreach Activities and Capacity Building Programs

Sakura Science Plan (SSP) 2022

“Sakura Science Plan (SSP)” funded by JST/MEXT is a capacity building program provided by RESTEC to AFSIS using JAXA’s agromet data. The participants for the program are selected from the ASEAN member countries to learn about Remote Sensing (RS) applications in agriculture including crop production and distribution, statistics, irrigation, policy planning and smart agriculture.

In 2022, the SSP was held as a series of online training from 18 October to 22 November 2022 on remote sensing technology and its application in agriculture, satellite-derived agrometeorological information for agriculture with an emphasis on image interpretation, and comprehensive discussion on the practical use of remote sensing in agriculture.



SAKURA Science Plan in 2021 and SAKURA Science Plan 2022
Online Training due to COVID-19 situation

Satellite-Derived Rice Planted Area Data for AFSIS’s Rice Growing Outlook (RGO)

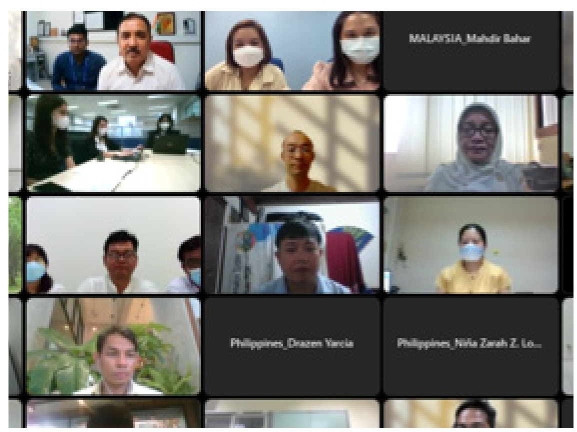
Training program on “Satellite-Derived Rice Planted Area Data for AFSIS’s Rice Growing Outlook (RGO)” for Agriculture Management in the ASEAN was organised in collaboration with SAFE, JAXA, VNSC and AFSIS on 14 November 2022. It was a hybrid event with online and in-person participants at the APRSAF-28 held in Hanoi, Vietnam.

The training demonstrated the use of INAHOR using PALSAR-2 data for rice planted area estimation with machine learning technology on the Google Earth Engine (GEE). The main trainees for this training were agricultural statisticians working for the Ministry of Agriculture in ASEAN countries. Twenty-three trainees from nine ASEAN member states attended the training.

Data for AFSIS’s Rice Growing Outlook (RGO)

Another training program on “Satellite-Derived Agrometeorological Data for AFSIS’s Rice Growing Outlook (RGO)” for Agriculture Management in the ASEAN was held under ISRO/JAXA/GISTDA partnership on 11 July 2022. ISRO demonstrated the Meteorological & Oceanographic Satellite Data Archival Centre (MOSDAC) / Visualisation of Earth Observation Data and Archival System (VEDAS) system and provided training sessions on using the VEDAS platform.

The event was attended by twenty six statisticians from eight ASEAN countries, including Vietnam, Cambodia, the Philippines, Indonesia, Thailand, and Malaysia, and was deemed a great success. Trainees have learned about the use of Indian Satellite derived agrometeorological information through the MOSDAC and VEDAS systems to improve the capabilities of satellite based products to solve the common problems in agricultural information systems.



Trainees have learned about how to use JAXA Rice Mapping Tool “INAHOR” on the Google Earth Engine as reference information for generating AFSIS’s RGO report and to improve utilisation of satellite derived information to solve the common problems in agricultural information systems in each member state.

Paddy Rice Recognition in Taiwan

Paddy fields in Taiwan have a very limited area that changes rapidly and is irregularly distributed. Field survey is labour intensive and not timely. In this study, paddy field recognition methodologies were carried out with the integration of optical and radar images ingested in Taiwan Data Cube (TWDC).

FORMOSAT-2 images of Hualien city with cloud masks were acquired which showed a growing period of paddy rice. SENTINEL-1 images also showed the same period images and water body reflecting made the watering period images were found to be much clearer in the SENTINEL-1 images.

The advantages of integration of FORMOSAT-2 and SENTINEL-1 images were:

FORMOSAT-2 data with higher resolution images can be used to obtain confident paddy rice area if ground truth is limited.

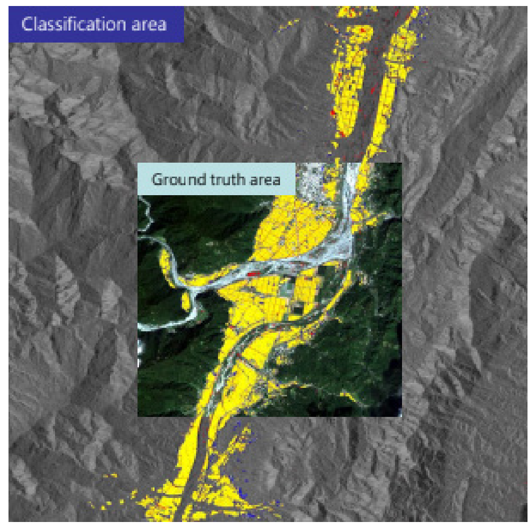
The paddy rice area obtained by using FORMOSAT-2 data can be applied as training data to train the AI model using SENTINEL-1 data.

Then, the cloud free SENTINEL-1 data can be used to obtain paddy rice area for whole study area.

The below image is the flowchart of paddy rice recognition with integration of FORMOSAT-2 and SENTINEL-1:

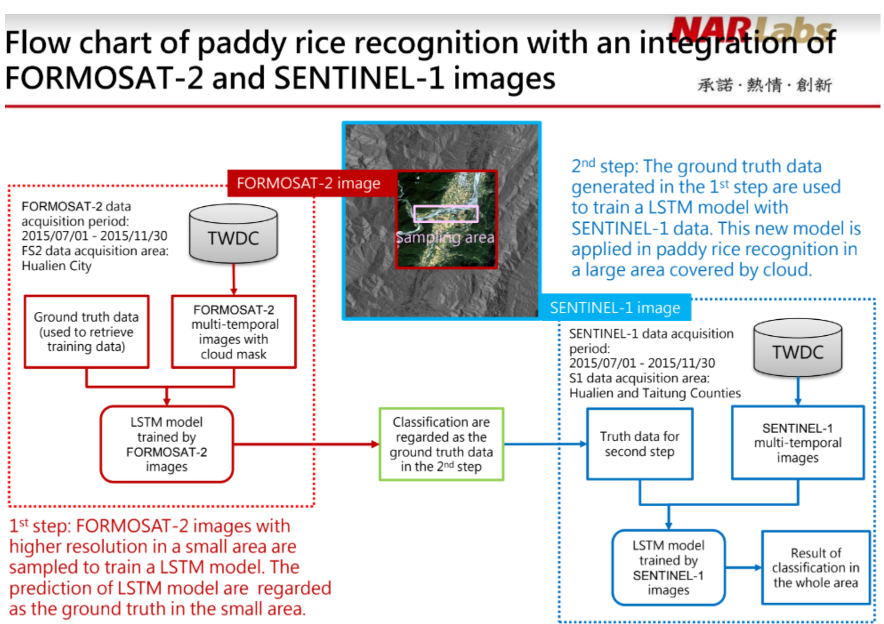
Results

The paddy field survey shared by the Agriculture and Food Agency is regarded as the ground truth data and used to validate the result of prediction.



Legend

Color	Truth	Prediction	Abbreviation and Meaning
Yellow	True	Positive	TP
Red	False	Positive	FP, Commission Error
Blue	True	Negative	TN, Omission Error
Transparent	False	Negative	FN



Conclusions

TWDC provides a convenient way to integrate remote sensing data and processing algorithms to generate decision support information. In this study, images for paddy rice identification were obtained and processed under TWDC. Long short-term memory (LSTM) Recurrent neural network (RNN) AI model was applied to identify paddy rice area by using optical and radar satellite images.

- By the adjustable gate weightings (including input, output and forget gates), LSTM algorithm can perform better in capturing the long term temporal information inherent in time series data.
- Due to the cloud coverage, the applicable spatial area in optical images generally is limited. However, because of the better spatial and temporal resolution of optical images, higher accuracy of identified results normally can be obtained when compared in using radar images.
- In this case the identified results with optical images are applied as training data to train the AI model with SAR images. Then, the larger coverage of Reidentified paddy rice area can be obtained.

Result (Pixel)	Predict Rice	Predict Non-rice	Total	Producer Accuracy	Overall Accuracy
Rice	156043	15306	171349	0.91	0.98
Non-rice	24896	2010465	2035361	0.99	
Total	180939	2025771	2206710		
User Accuracy	0.86	0.99			

Confusion Matrix

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, CEOS, and APRSAF SAFE.

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.