Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

APCAS/24/A3.2

ASIA AND PACIFIC COMMISSION ON AGRICULTURAL STATISTICS

30TH SESSION

19–24 May 2024
Kathmandu (Nepal)

BETTER PRODUCTION | BETTER NUTRITION | BETTER ENVIRONMENT | BETTER LIFE

Forecast on Rice Yield Using Satellite Data

HOSAKA Masahiro
IDA Reina
Deputy Director, Statistics Planning Division, Statistics Department
Ministry of Agriculture, Forestry and Fisheries

MAFF
Ministry of Agriculture, Forestry and Fisheries

SAFF
データの力で。
農林水産統計
Statistics of Agriculture, Forestry and Fisheries

Outline of Contents

1 Rice Yield Forecast by EO

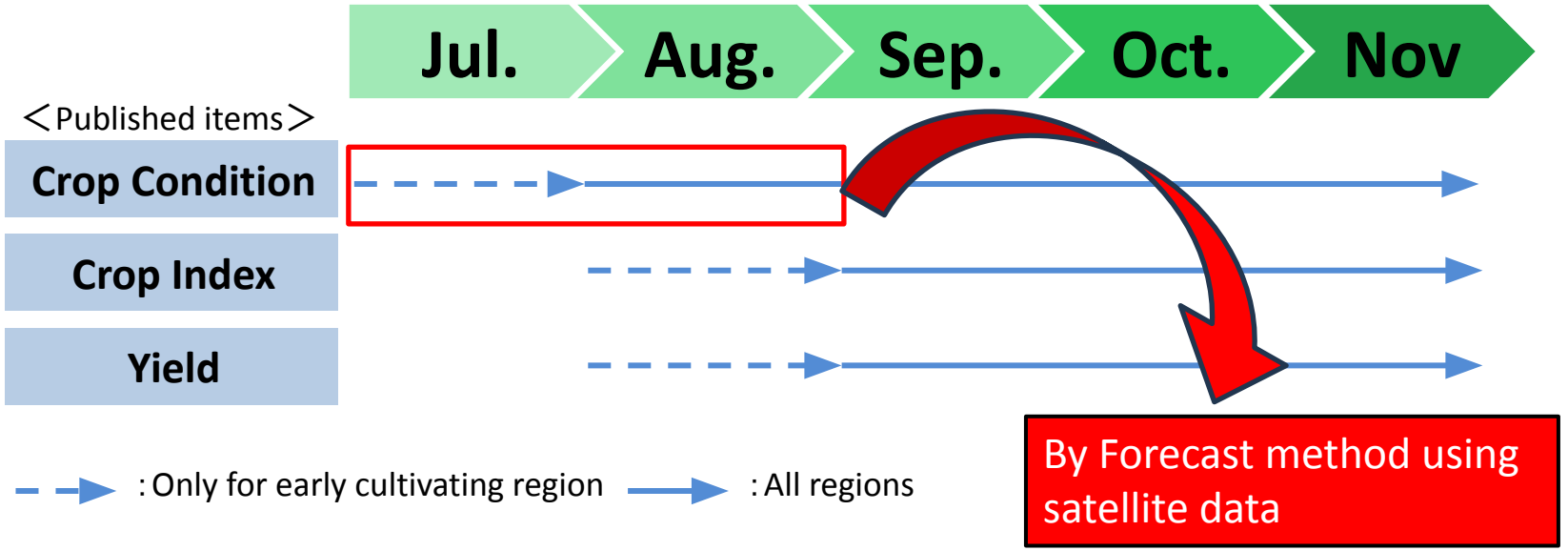
2 Development of Land Parcel Information Database

3 Research on Measuring Crop Area by EO

4 International Cooperation

1 Outline of the Rice Production Survey in Japan

◎ Outline of Rice Production Survey in Japan



◎ Crop Condition and Crop Index

Text information to evaluate Crop conditions by 5 grades

Crop Conditions	Poor	Below Normal	Normal	Above Normal	Good
Crop Index	less than 94	95-98	99-101	102-105	more than 106
Evaluation Standard	Crop Index = “Forecasted Yield per 10 ares” / “Normal Yeild per 10 ares” * 100				

2 Introduction of Satellite Data into Forecast on Rice Yield

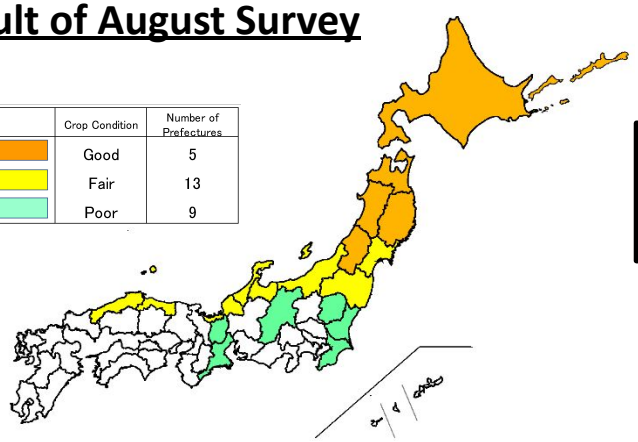
Improvements

- Introducing the new forecast method made us possible to publish the results **more widely**.
- Actual measurement surveys is no longer needed.

＜Before 2019＞

◎ **Result of August Survey**

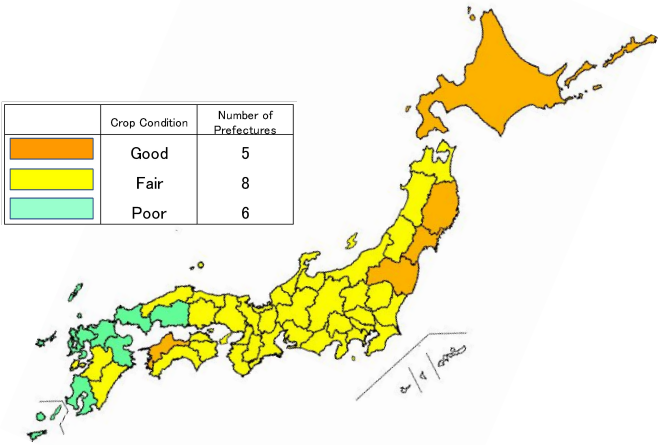
Crop Condition	Number of Prefectures
Good	5
Fair	13
Poor	9

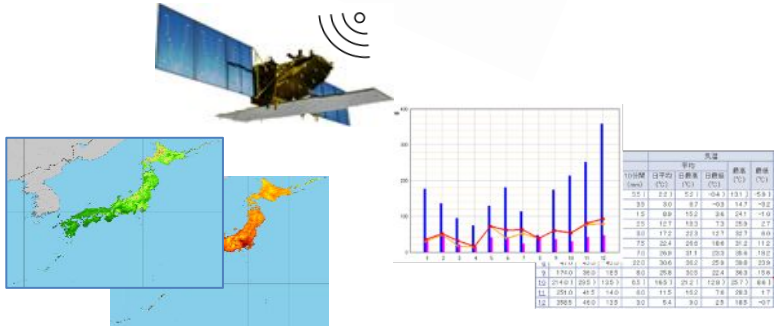


◎ **Survey Method**

＜After 2020＞

Crop Condition	Number of Prefectures
Good	5
Fair	8
Poor	6





3 Validation Results of the New Forecasting Method

- The difference between forecasted yield and official data calculated by actual measurement was less than 2% in most prefectures.
- Although the accuracy was lower in some prefectures due to damages from subsequent typhoons, which is difficult to predict based on the data as of 15 August (Survey date of the August Survey), effects other than the typhoons were forecasted mostly.
- Therefore, it was decided that the new method could be introduced into the August survey because the result is forecasted based on the assumption that the weather and damage conditions after 15 August is normal.

◎ Comparison between forecasted and measured yield in late cultivating prefectures

Prefecture	Error(%)	Prefecture	Error(%)	Prefecture	Error(%)	Prefecture	Error(%)
Gunma	1.68	Aichi	0.21	Hiroshima	0.81	Saga	6.05
Saitama	0.96	Kyoto	0.30	Yamaguchi	1.35	Nagasaki	3.72
Tokyo	0.40	Osaka	0.66	Tokushima	1.11	Kumamoto	2.88
Kanagawa	0.44	Hyogo	0.33	Kagawa	0.95	Oita	2.01
Yamanashi	0.66	Nara	0.21	Ehime	0.73	Miyazaki	1.43
Gifu	0.24	Wakayama	0.79	Kochi	1.14	Kagoshima	1.13
Shizuoka	0.27	Okayama	1.28	Fukuoka	3.50		

Note : The errors were calculated by averaging difference between forecasted and measured yield for 16 years (2002 to 2017).

4 Satellite and Other Weather Data Used for Forecast

◎ Data used for explanatory valuables in forecasting formulas

	Observed Data	Observed Element	Data Source	Organization
Satellite Data	Precipitation		GSMaP	JAXA
	Surface Temperature		LP DAAC	NASA/USGS
	Solar Radiation	Shortwave Radiation	JASMES	JAXA
	Vegetation Index	Reflectance	LP DAAC	NASA/USGS
Meteorological Data	Precipitation	Daily	AMeDAS(Automated Meteorological Data Acquisition System)	Japan Meteorological Agency (JMA)
		Hourly-Max		
	Temperature	Daily Mean		
		Daily Max		
		Daily Min		
	Hours of Sunshine			
	Wind Speed	Max		
Others	Location of Paddy Field		Digital National Land Information	Geospatial Information Authority of Japan(GSI)
	Municipal Boundary			
	Boundary of Crop Situation Indicated Area		MAFF	MAFF

5 Objective variable and Explanatory variables

Objective variable

Yield per 10 a (thousand square meters)

Explanatory variables

All Data (702)

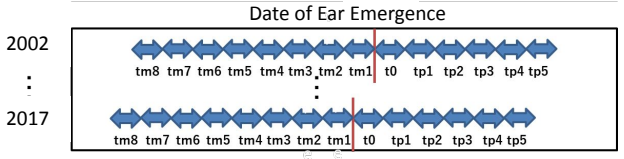
Satellite Data (442)

Meteorological Data (260)

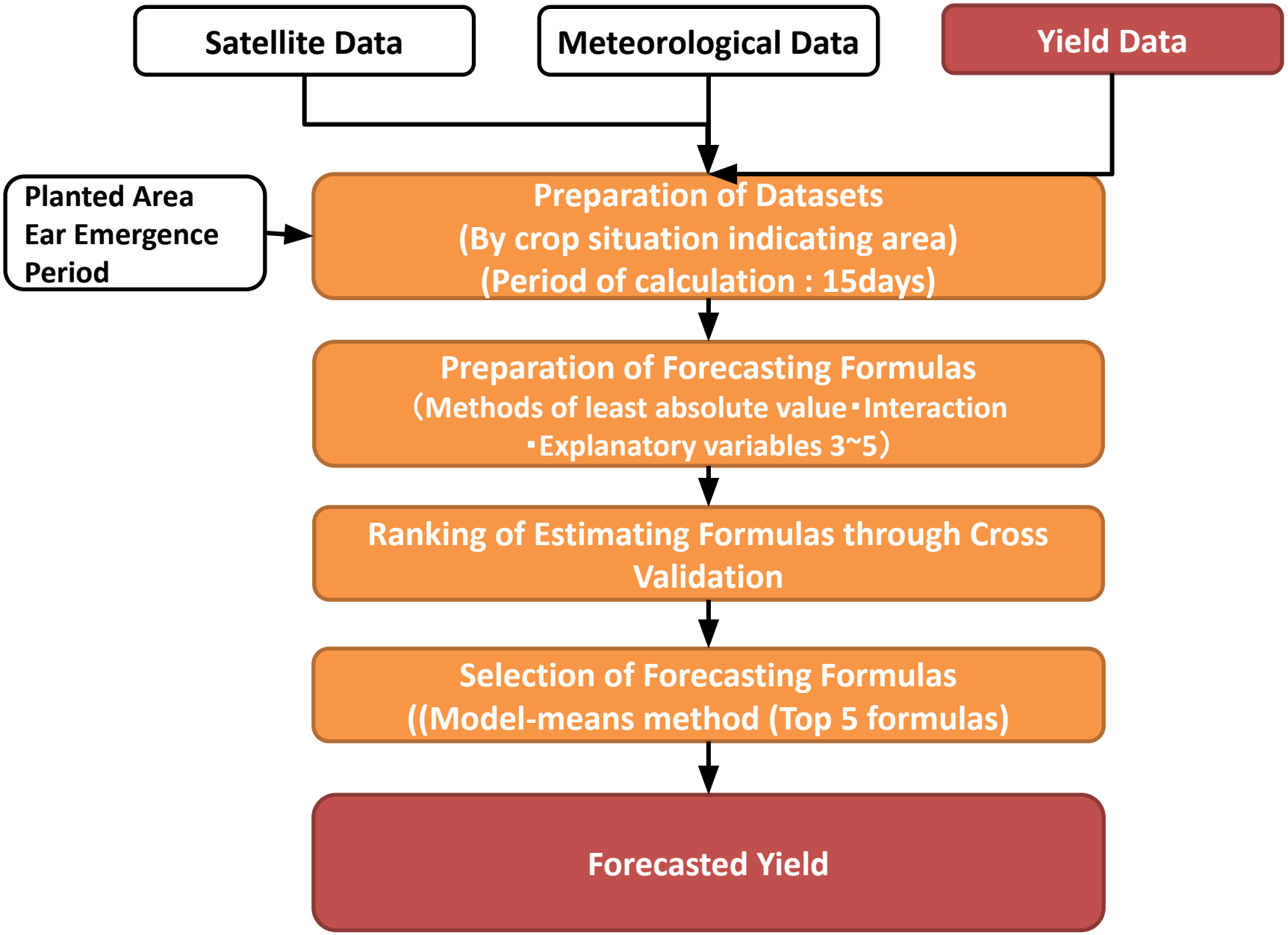
1 Amount of Solar Radiation (13)	2 Vegetation Index (13)	3 Surface Temperature (13)	4 Precipitation (13)	5 Accumulated Amount of Solar Radiation (78)	6 Accumulated Vegetation Index (78)	7 Accumulated Surface Temperature (78)	8 Accumulated Precipitation (78)	9 Accumulated SWR x EVI (78)	10 Temperature (13)	11 Hours of Sunshine (13)	12 Precipitation (13)	13 Wind Speed (13)	14 Accumulated Precipitation (78)	15 Accumulated temperature (78)	16 Differential Temperature (13)	17 Abnormal Temperature (13)	18 Threshold Precipitation (13)	19 Threshold Wind Speed (13)

Note : The number in parentheses are number of datasets.
The period of one dataset is 15 days and the total datasets are 13, which are tm1～tm8 prior to date of ear emergence and t0～tp4 subsequent to date of ear emergence.

(Ref.) Pattern diagram of calculation period



6 Creation of Forecasting formulas



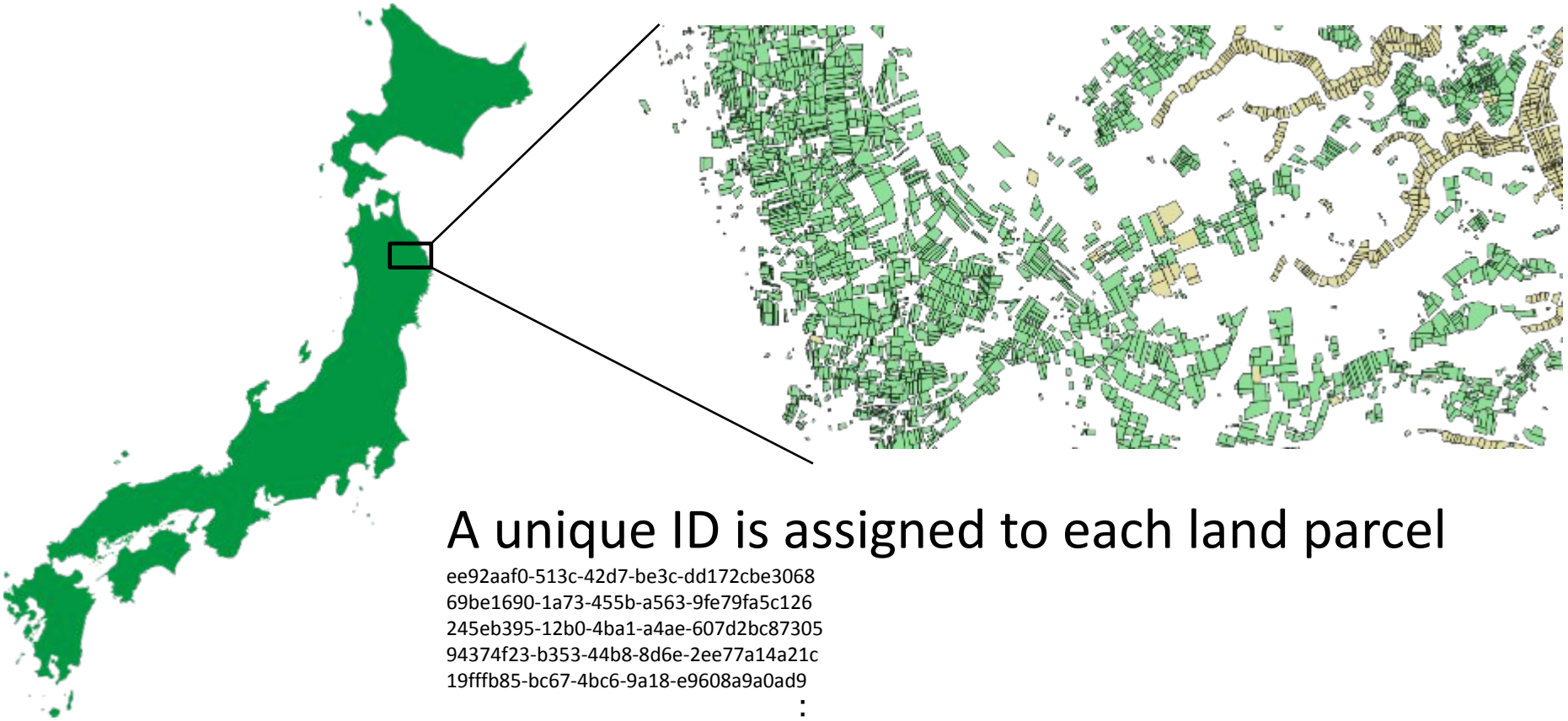
7 Land Parcel Information Database

- Land parcel is farmland plot information which is developed based on the shape of each farmland on satellite images by Ministry of Agriculture, Forestry and Fisheries (MAFF).
- Land parcel information can be downloaded freely.

(Source) Sample image of land parcel data superimposed on an electronic topographic map of the Geographical Survey Institute

7 Land Parcel Information Database

- MAFF assigns IDs to all 30million land parcels in Japan
- MAFF manages IDs and updates each land parcel



A unique ID is assigned to each land parcel

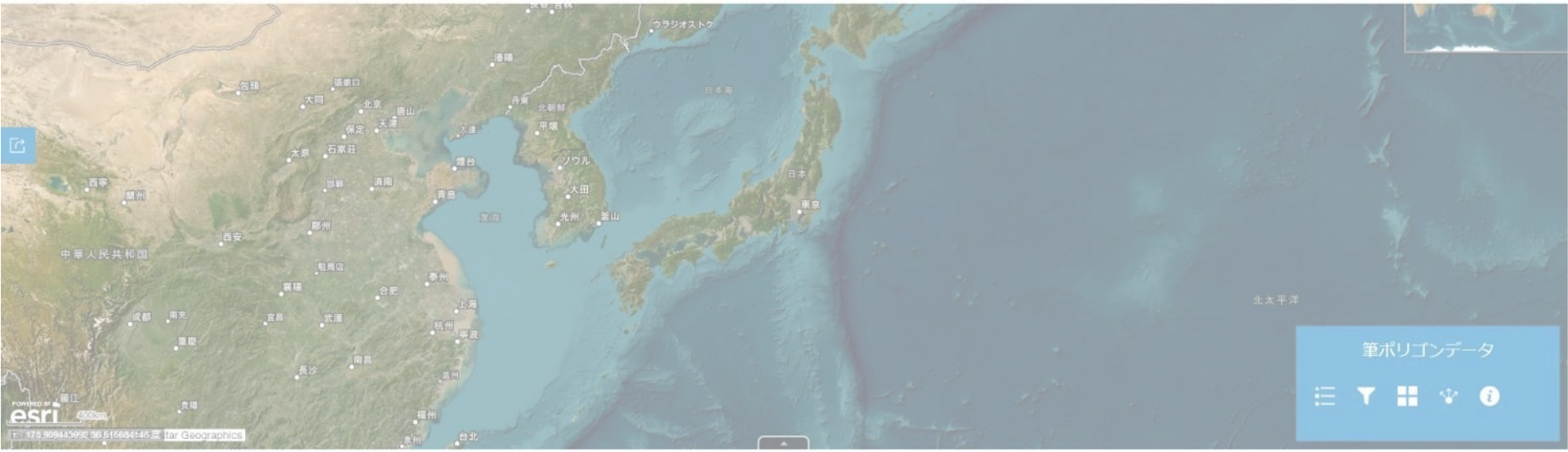
ee92aaf0-513c-42d7-be3c-dd172cbe3068
69be1690-1a73-455b-a563-9fe79fa5c126
245eb395-12b0-4ba1-a4ae-607d2bc87305
94374f23-b353-44b8-8d6e-2ee77a14a21c
19fffb85-bc67-4bc6-9a18-e9608a9a0ad9
⋮

7 Land Parcel Information Database

- Land parcel information and data can be viewed and downloaded at the following website.

https://open.fude.maff.go.jp/

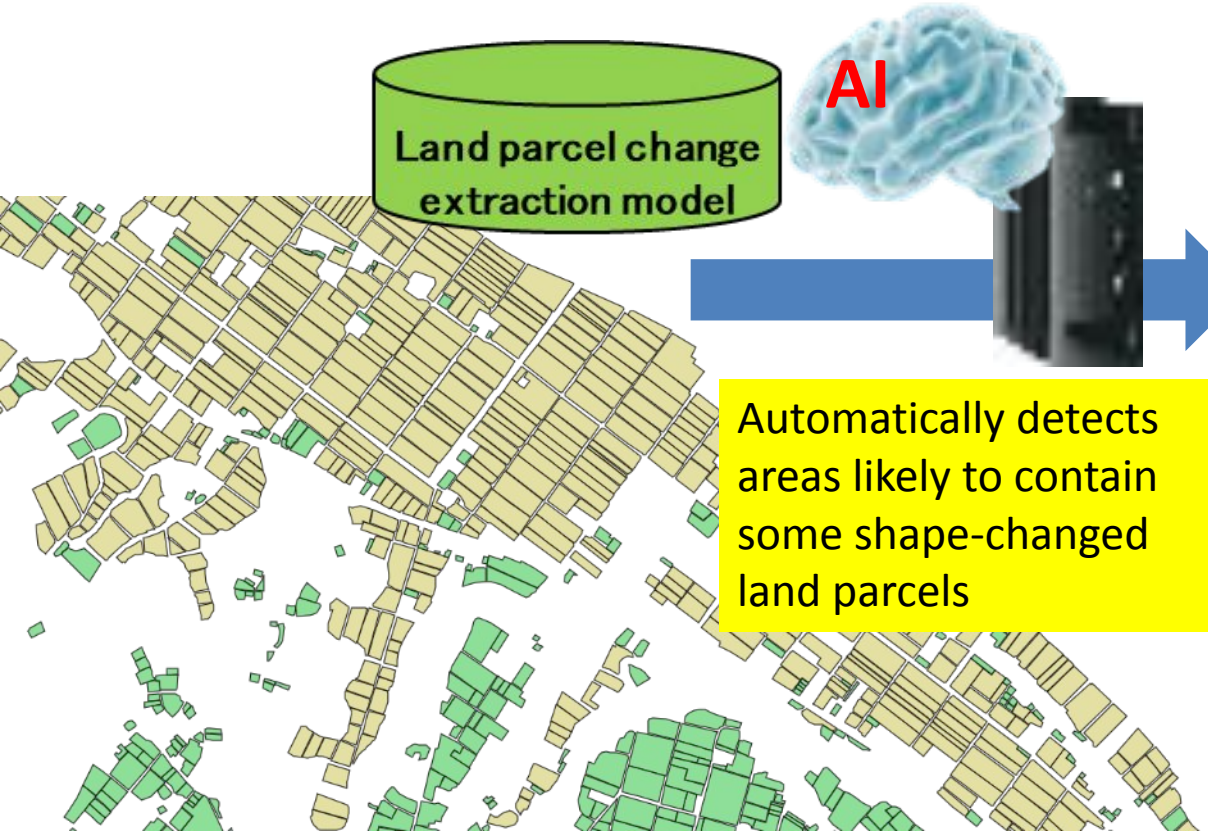
筆ポリゴン公開サイト



7 Land Parcel Information Database

【Before】
Staff manually checks each polygons on the satellite image one by one for update.

【Now】
AI identifies areas likely to contain some shape-changed land parcels by comparing and analyzing satellite image data.

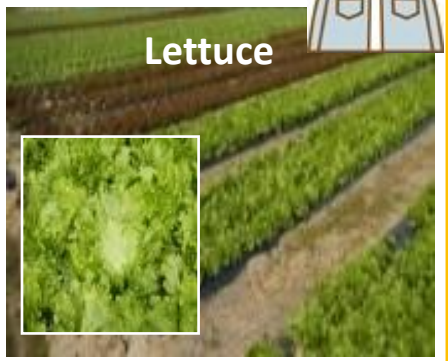


8 Research on Measuring Crop Area by EO

Developing efficient way of identifying planted crop for each land parcel by analyzing satellite image data using AI

Current Method

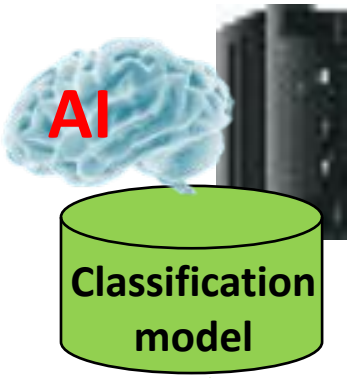
On site research for knowing the cropping situation by regional office staff and enumerato



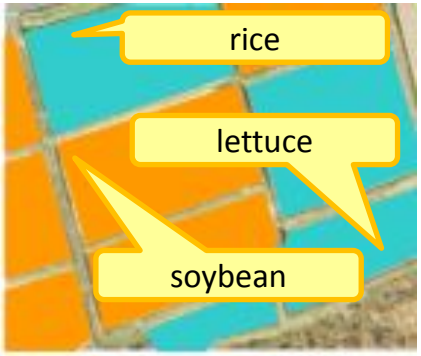
New method

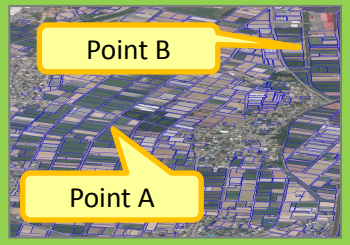
Satellite image

Image analysis



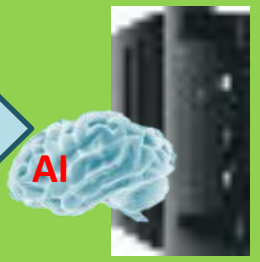
Judge





A=soybean, B=lettuce,…

Develop a model by machine learning



Background Information – JAPAN

	Rice Production Forecasting using satellite data	Land Parcel Information Database
Lead Ministry/Agency	MAFF	MAFF
Policy mandate	—	—
Legislative mandate (if any)	—	—
Stakeholders involved	Private-sector corporation	Private-sector corporation
Interagency collaborations	—	—
Privacy legislation	—	—
Privacy considerations	—	—

Background Information (cont.)– JAPAN

	Rice Production Forecasting using satellite data	Land Parcel Information Database
Satellite imagery source(s)	—	WordView（by Maxar Technologies, Inc.） etc.
Type of imagery used (optical, SAR, etc.; including satellite system)	—	Optical Satellite Image
Spatial and Temporal resolution	Precipitation：10 km・1 Day Amount of Solar Radiation：5 km・1 Day Surface Temperature：5 km・1 Day Surface Reflectance：1 km・1 Day	Ground Resolution：50 cm etc.
Ancillary data	—	—
Data processing (infrastructure on-site or cloud-based)	—	—
Area covered by EO data analysis (national/sub-national)	Nationwide by crop situation indicating area	—

Background Information (cont.) – JAPAN

	Rice Production Forecasting using satellite data	Land Parcel Information Database
Crops covered	Paddy Rice	—
Statistics produced (ex. Crop type mapping, area estimation)	Forecasting Yield per 10 areas	Population information for statistical surveys
Frequency that statistics are produced	July and August every year	—
Dissemination of statistics	Web page publication (PDF, Excel)	—
Size of geospatial team	—	—
Roles in geospatial team	—	—

In-situ data– JAPAN

	Rice Production Forecasting using satellite data	Land Parcel Information Database
Data/survey source	—	—
Lead agency	—	—
Sampling approach	—	—
Data collection approach	—	—
Variables collected	—	—
Frequency of data collection	—	—

ASEAN **F**ood **S**ecurity **I**nformation **S**ystem

- Ensure food security
- Maintain, compile, and provide accurate food security information and agricultural statistics

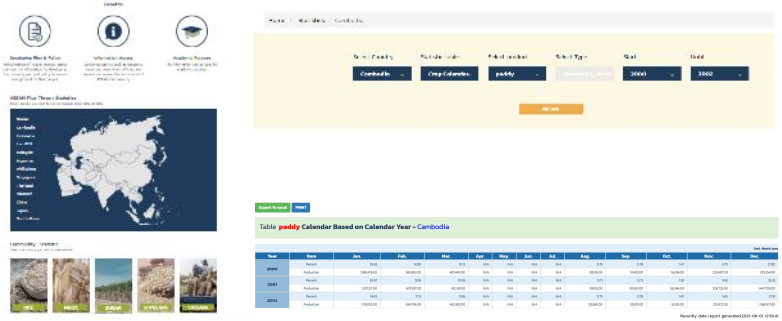
Background and Mechanism of AFSIS

- Established at the 1st Meeting of AMAF Plus Three
- Operated with contribution and Experts from MAFF, Japan
- In-kind contribution by MOAC, Thailand

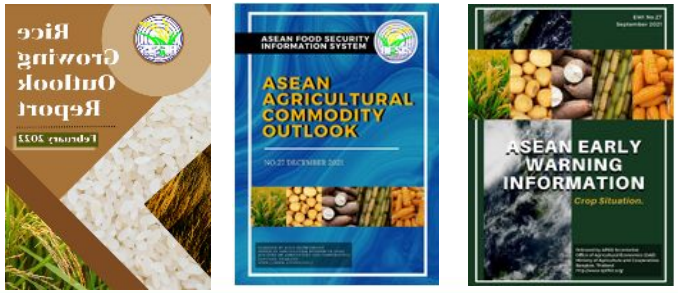
Basic Activities of AFSIS

- Target Crops

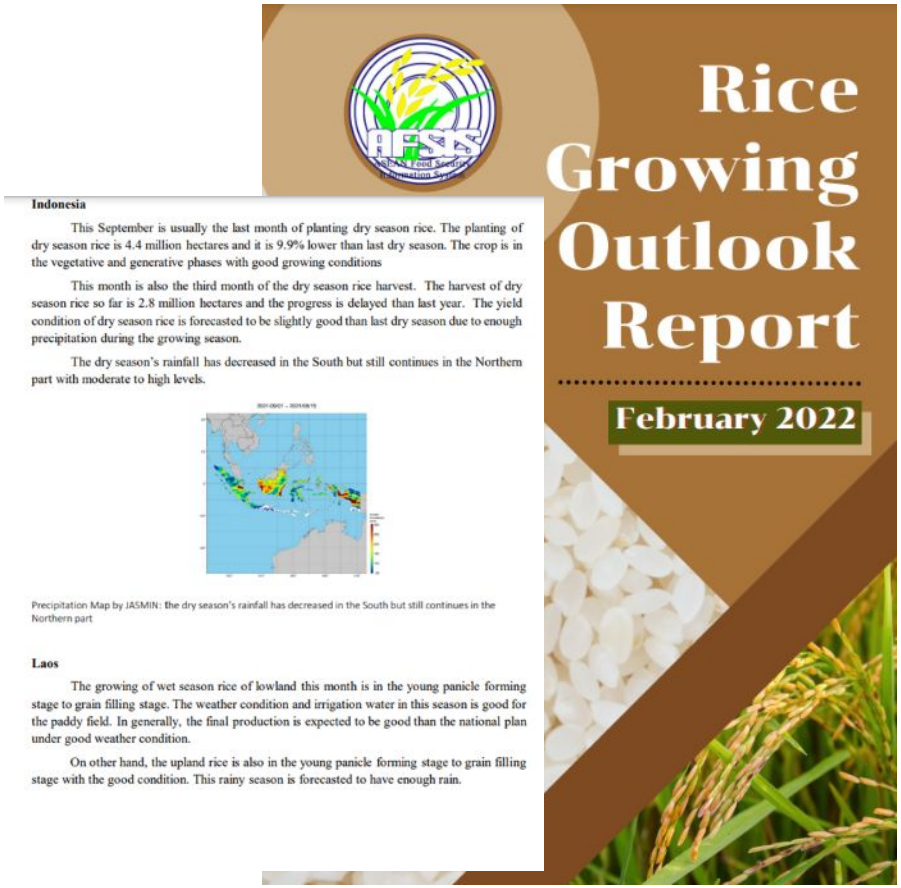
- Database on Agricultural Statistics



- Agricultural Commodity Outlook Early Warning Information



The Activity Utilizing Satellite Data

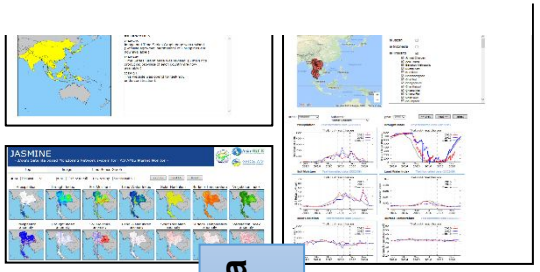


RGO Report

- Satellite Meteorological Data＋Field Information
- Contribution to GEOGLAM/AMIS
- Publish monthly since Oct 2013
- Supported by JAXA

RGO Mechanism

JASMAI
<database on satellite observed data>



Support

JAXA Japan Aerospace Exploration Agency

Support

AFSIS Secretariat

Data Use

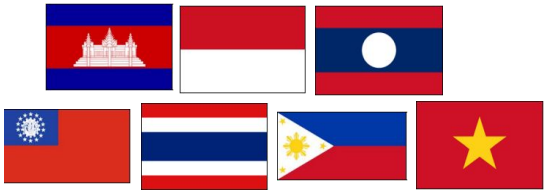
Verification

Report

RGO Compilation

Report

7 Countries in ASEAN



Field Information

International Initiatives
（G20/FAO）

Information

AMIS Agricultural Market Information System

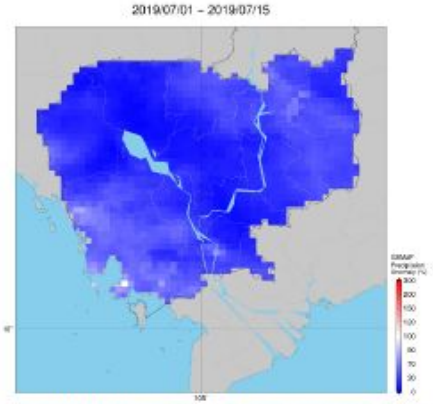
GEOGLAM Global Agricultural Monitoring

RGO Examples – Drought in 2019 -

July 2019

Cambodia

This month, the planted area of wet season rice reached to 63 % of the national plan. The early wet season rice is in flowering to grain filling stage. The tendency for shortage of rainfall continues nationwide from last month to this month, despite the rainy season. At present, it's necessary agricultural water for planting and growing of wet season rice. The serious drought damage may be concerned depending on future rainfall conditions. The drought is causing in the north-west area mainly and the affected area on paddy rice reached to 5% of cultivated area. While, the growing condition out of drought area is fairly good.

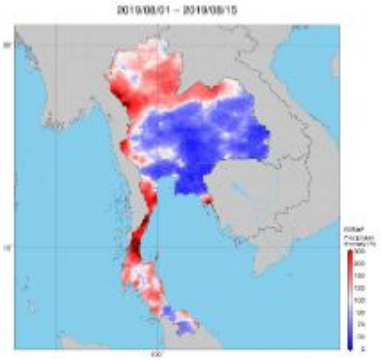


Precipitation anomaly map by JASMIN: the tendency for shortage of rainfall continues nationwide

August 2019

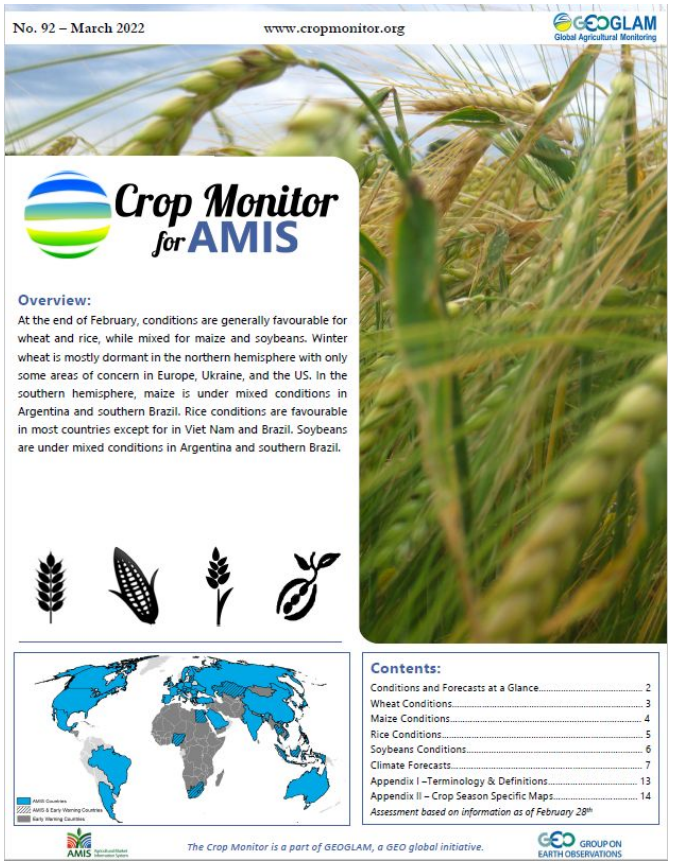
Thailand

The wet season rice is in the tillering stage to young panicle forming stage. The growing condition of wet season rice is not good due to less rain than normal in many areas especially in the Northeastern region which is the main rainfed paddy field in Thailand. By the shortage of rainfall affected the rice stem dry and poor panicles growing condition in some areas. For the Northern and Central region, the growing condition is fair.



Precipitation anomaly map by JASMIN: The growing condition of wet season rice is not good due to less rain than normal in many areas especially in the Northeastern region

Contribution to International Framework



No. 92 – March 2022 www.cropmonitor.org

GEOGLAM Global Agricultural Monitoring

Crop Monitor for AMIS

Overview:

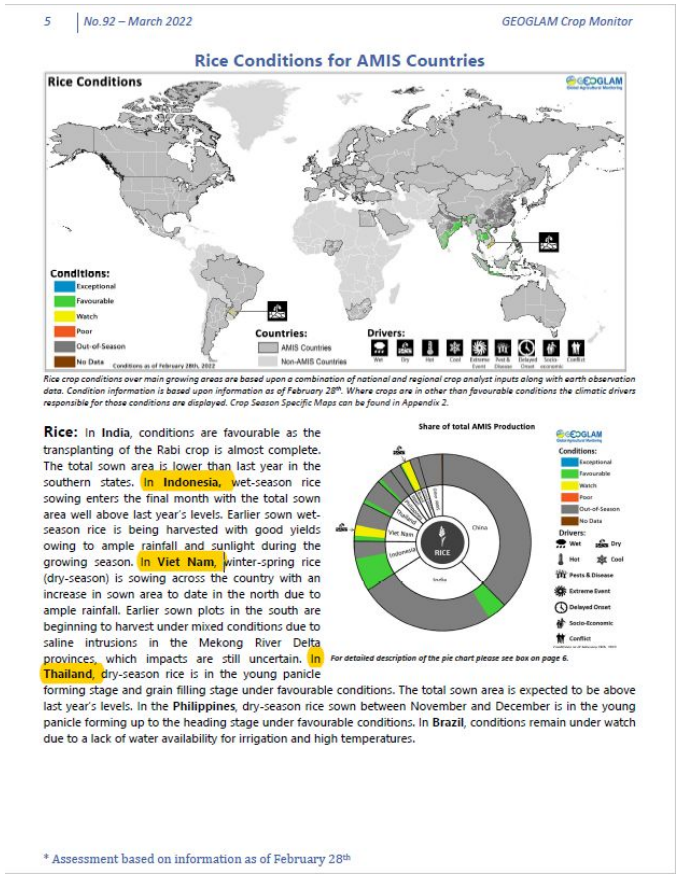
At the end of February, conditions are generally favourable for wheat and rice, while mixed for maize and soybeans. Winter wheat is mostly dormant in the northern hemisphere with only some areas of concern in Europe, Ukraine, and the US. In the southern hemisphere, maize is under mixed conditions in Argentina and southern Brazil. Rice conditions are favourable in most countries except for in Viet Nam and Brazil. Soybeans are under mixed conditions in Argentina and southern Brazil.

Contents:

Assessment based on information as of February 28th

The Crop Monitor is a part of GEOGLAM, a GEO global initiative.

GEO GROUP ON EARTH OBSERVATIONS



Rice Conditions for AMIS Countries

Rice Conditions

Conditions: Exceptional, Favourable, Watch, Poor, Out-of-Season, No Data

Countries: AMIS Countries, Non-AMIS Countries

Drivers: Wet, Dry, Hot, Cool, Extreme Event, Pests & Disease, Delayed Onset, Socio-Economic, Conflict

Rice crop conditions over main growing areas are based upon a combination of national and regional crop analyst inputs along with earth observation data. Condition information is based upon information as of February 28th. Where crops are in other than favourable conditions the climatic drivers responsible for those conditions are displayed. Crop Season Specific Maps can be found in Appendix 2.

Rice: In **India**, conditions are favourable as the transplanting of the Rabi crop is almost complete. The total sown area is lower than last year in the southern states. In **Indonesia**, wet-season rice sowing enters the final month with the total sown area well above last year's levels. Earlier sown wet-season rice is being harvested with good yields owing to ample rainfall and sunlight during the growing season. In **Viet Nam**, winter-spring rice (dry-season) is sowing across the country with an increase in sown area to date in the north due to ample rainfall. Earlier sown plots in the south are beginning to harvest under mixed conditions due to saline intrusions in the Mekong River Delta provinces, which impacts are still uncertain. In **Thailand**, dry-season rice is in the young panicle forming stage and grain filling stage under favourable conditions. The total sown area is expected to be above last year's levels. In the **Philippines**, dry-season rice sown between November and December is in the young panicle forming up to the heading stage under favourable conditions. In **Brazil**, conditions remain under watch due to a lack of water availability for irrigation and high temperatures.

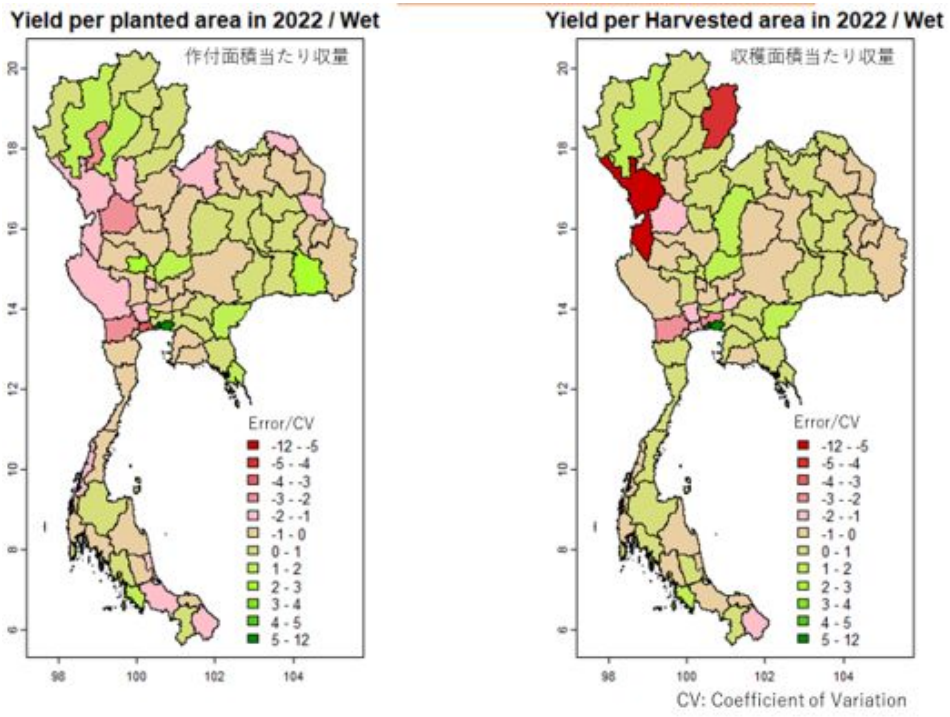
Share of total AMIS Production

For detailed description of the pie chart please see box on page 6.

* Assessment based on information as of February 28th

Way Forward of RGO

- MAFF launched the new project to develop forecasting method of rice yield in the ASEAN, using satellite information.
- The proto-type method was developed in Thailand, applying Japan's experience.
- The error margin between the forecasts and published results is approx. 10%.



AFSIS-JAXA Cooperation on Rice Mapping Tool using Satellite Information

JAXA (Japan Aerospace Exploration Agency) developed the Rice mapping software **"INAHOR"** using ALOS-2 satellite data.

JAXA estimated the rice planting area in **Cambodia** and **Lao PDR** by INAHOR to be a feasibility study.

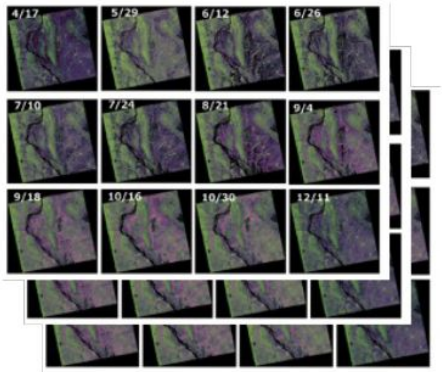
AFSIS/MAFF Japan and JAXA collaborate to distribute experiences of rice area estimation by INAHOR in ASEAN countries.

ALOS-2
(Advanced Land Observing Satellite-2)

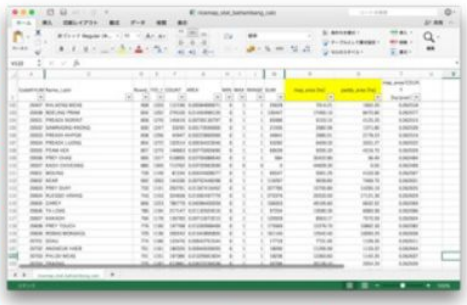
AFSIS-JAXA Cooperation on Rice Mapping Tool using Satellite Information

- Rice planted areas are identified by **time-series ALOS-2 data with AI (Artificial Intelligence) technology** classification model is automatically developed based on training data.
- **Accurate and adequate training data are therefore very important** to create accurate rice map.

Time-series ALOS-2 imageries

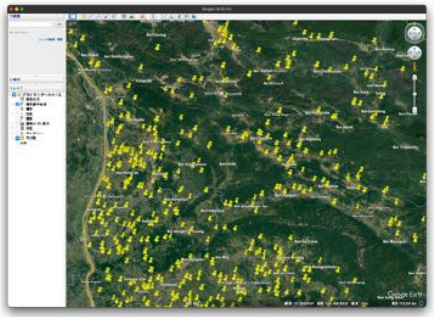


Location (Map)



Area (Value)

Training Data (location of paddy or non-paddy)

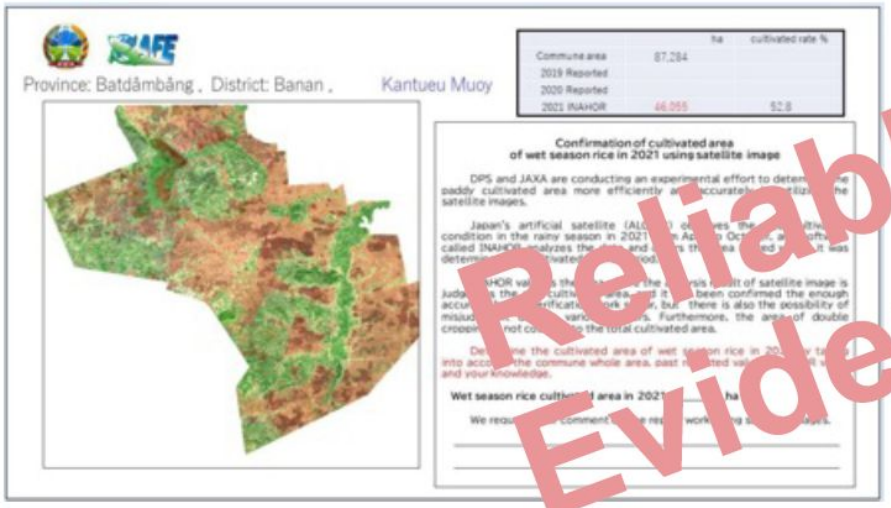


Google Earth

Training Data Sampling System & Google Earth

AFSIS-JAXA Cooperation on Rice Mapping Tool using Satellite Information

INAHOR will prepare the **Validation Sheet** by district/prefecture.



Validation sheet of INAHOR by district
(Example of Cambodia, 2021)

Paddy field distribution map

- Visual material to explain the reliability of statistics.
- Materials for planning for irrigation, land development.

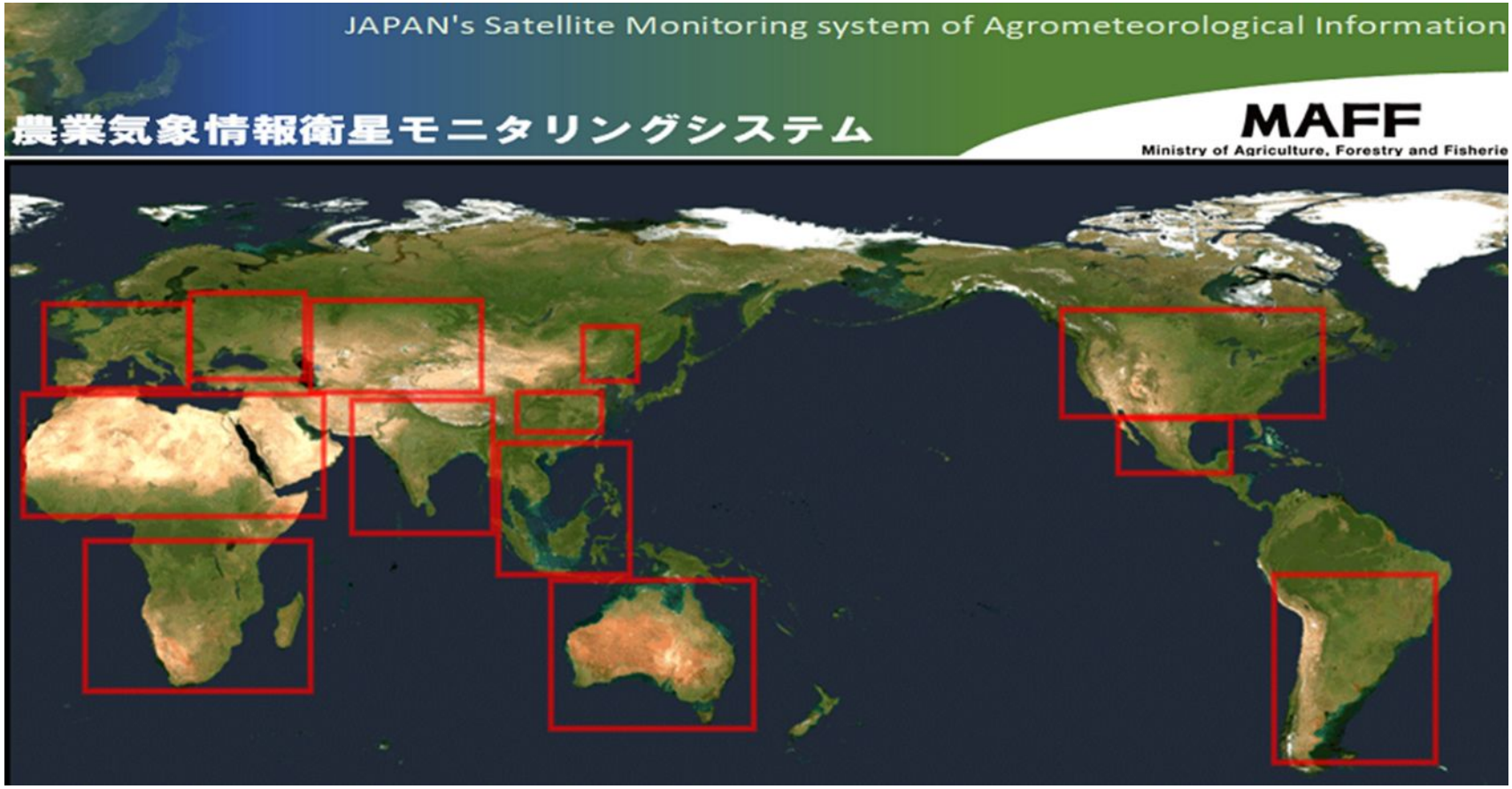
Total value on Paddy area

- Benchmarks for preparation of statistics by Reporting System.

[Mr. Ryuki Ikeda, MAFF/Japan, INAHOR WS@Vangvieng, 2023]

Ref. Outline of JASMAI

JApan's **S**atellite **M**onitoring system of **A**grometeorological **I**nformation



Ref. Outline of JASMAI

What is JASMAI

- Originally developed by **JAXA** and operated by **MAFF Japan**
- **Visualizing meteorological information** obtained by **satellite** observation to contribute to stabilize global food security

Ref. Outline of JASMAI

Target of JASMAI

- Almost the entire world focusing on 13 area including **Southeast Asia**

- Soil moisture content, Precipitation, Surface temperature, Solar radiation, Vegetation Index

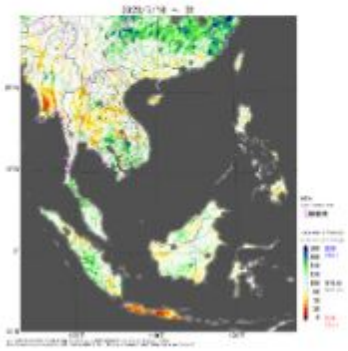
Ref. Outline of JASMAI

Function of JASMAI: MAP

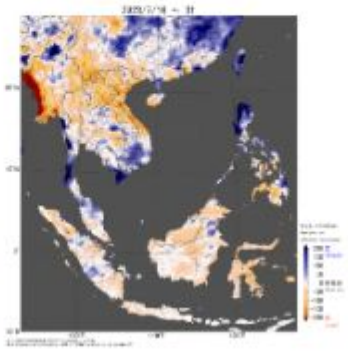
(1) Area : Southeast Asia (2) Semi-month/Month : Semi-month (3) Period : 2023 Jul. 16～last day Latest

Comparison to normal

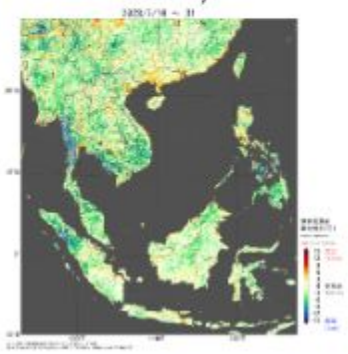
Soil Moisture ratio anomaly + Snow-covered Area



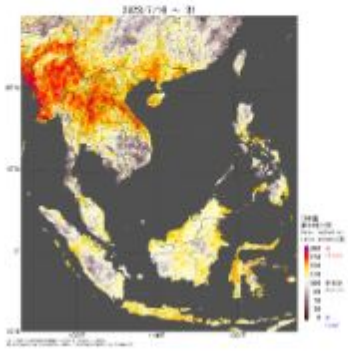
Precipitation difference anomaly



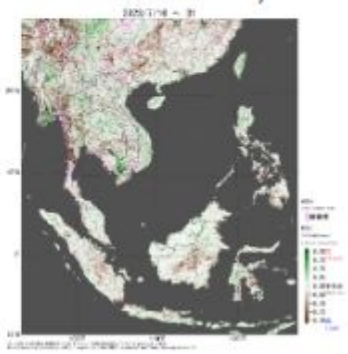
Surface temperature difference anomaly



Solar radiation ratio anomaly

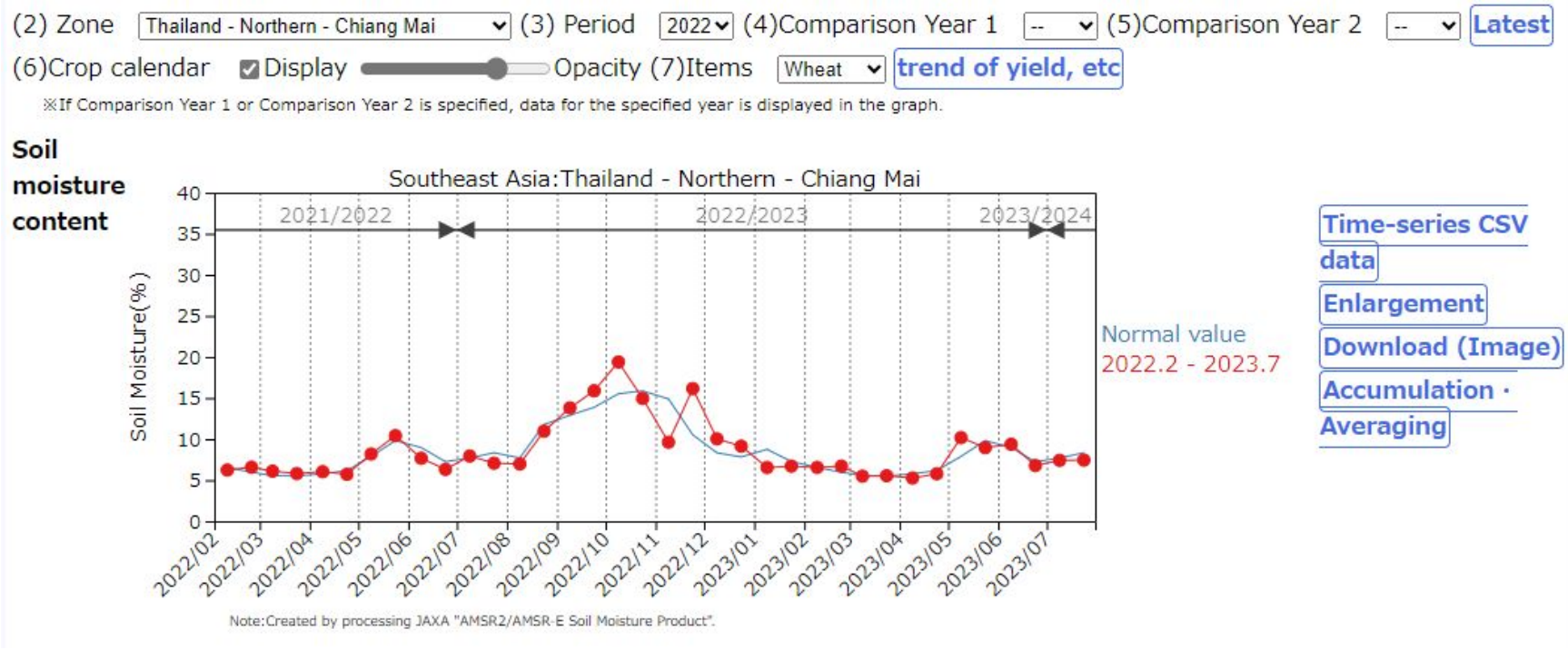


Vegetation index (NDVI) difference anomaly



Ref. Outline of JASMAI

Function of JASMAI: Graph



Ref. Outline of JASMAI

Access to JASMAI

- **Free access** anytime, anywhere via the internet

https://jasmai.maff.go.jp/en/

To search

“JASMAI English”

Thank You