



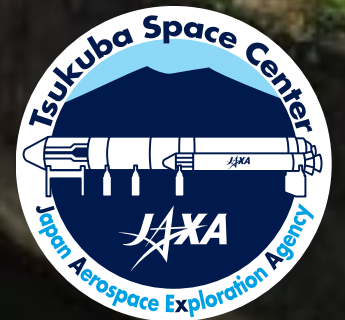
# Identification of Crop Calendar Using Satellite Data for Evaluation of Irrigation Project by JICA

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**Japan Aerospace Exploration Agency (JAXA)**

**11th AEOGSS Asia Pacific Symposium**

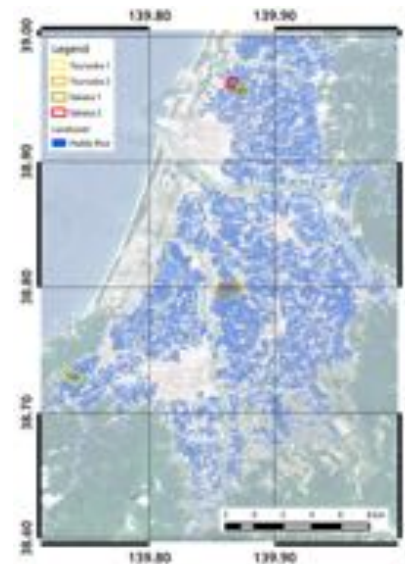
**@Kyoto, Japan  
24-26 October 2018**



# Asia-RiCE: Agriculture-Related Products

ID	Product
P1	<b>Rice Planted Area Estimates and Mapping</b>
P2	<b>Crop Calendars/Crop Growth Status</b>
P3	<b>Crop Damage Assessment</b>
P4	<b>Agro-meteorological Information Products</b>
P5	<b>Yeild/Production Estimation and Forecasting</b>

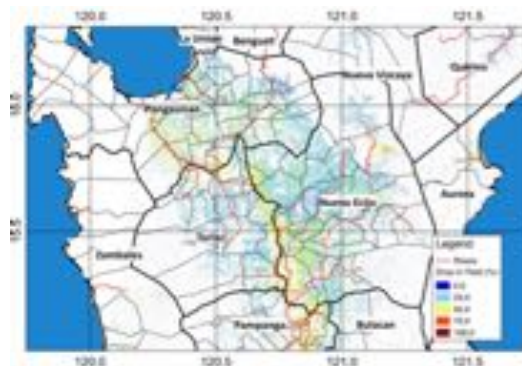
## Product Examples



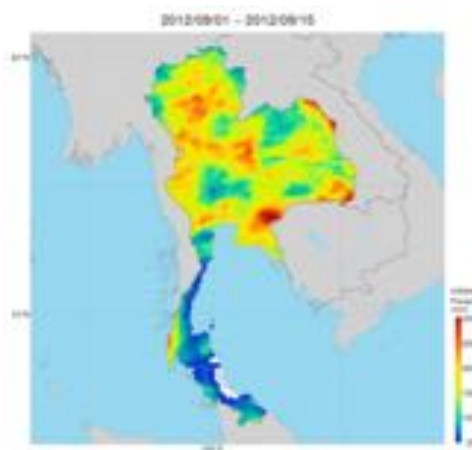
**P1: Planted Area**



**P2: Crop Calendar**



**P3: Crop Damage**



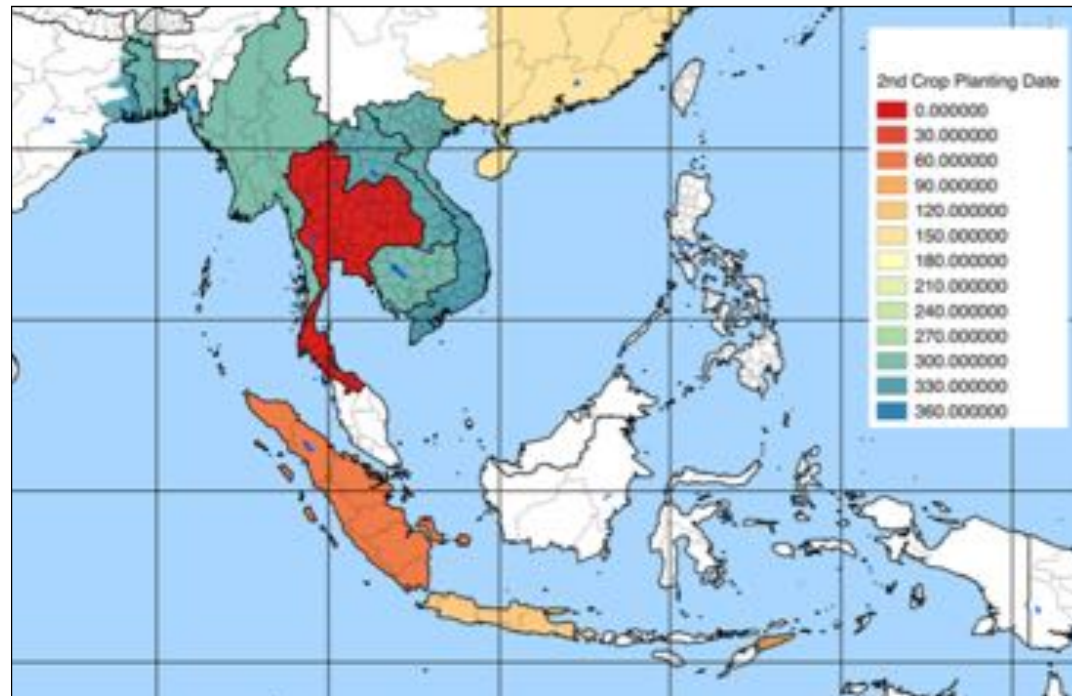
**P4: Precipitation**

<http://www.asia-rice.org>

# Crop Calendar

- Basic information for input data to crop models for estimating/forecasting crop yields
- Includes **cropping intensity**, planting date, and harvesting date etc
- However, no adequate data of time-series and detailed crop calendar
- Satellite-based observation can contribute to develop timely and detailed crop calendar.

## Rice Planting Date for 2nd Crop



[Sacks *et al.* GEB, 2010]

# Utilization of Crop Calendar in JICA Irrigation Project

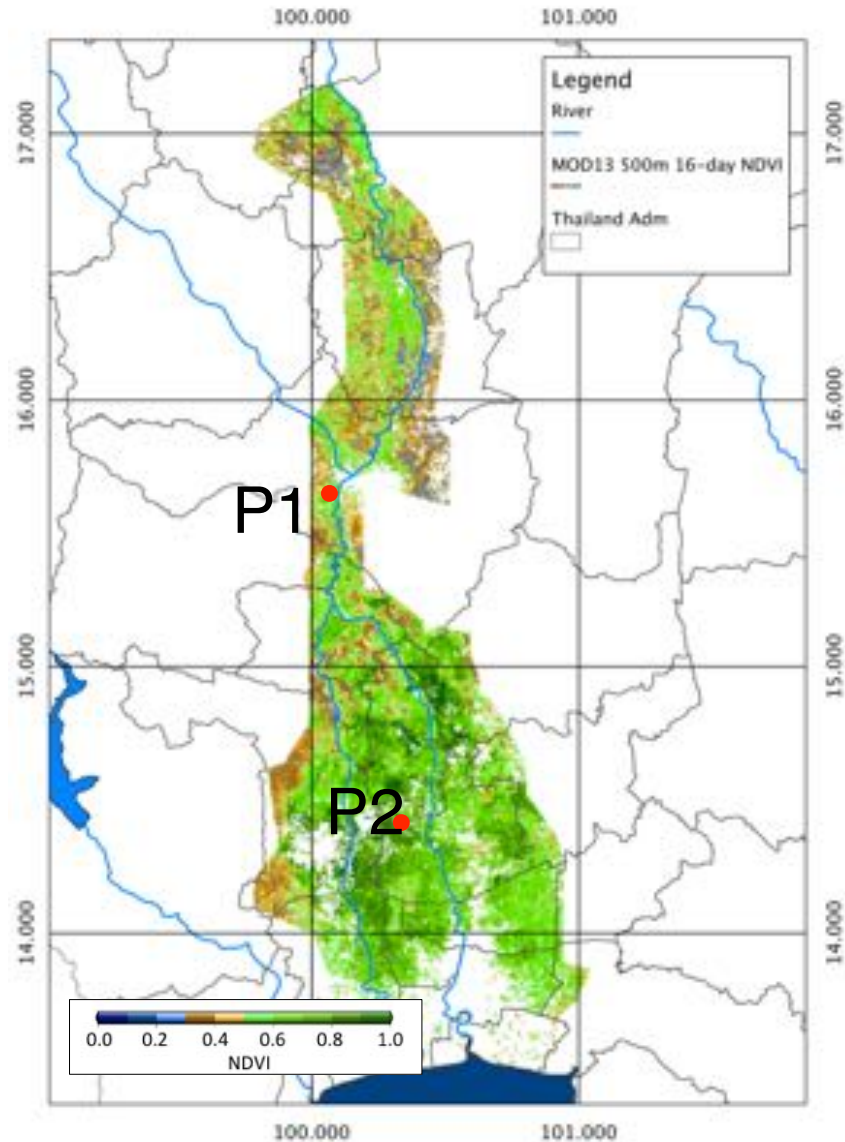
- Irrigation project improves local water resource availability.
- Evaluation indicators for irrigation project
  - cropping area, **crop intensity**, crop species etc.
- Indicators should have consistency before and after the project
  - Official statistical data availability (past data) and reliability
  - Statistics data are accumulated with administrative boundary, difficult to identify the effect only within the target area
- Collecting indicators in the project needs a lot of cost and labor

Satellite observation is expected to collect indicators for agricultural development project evaluations.



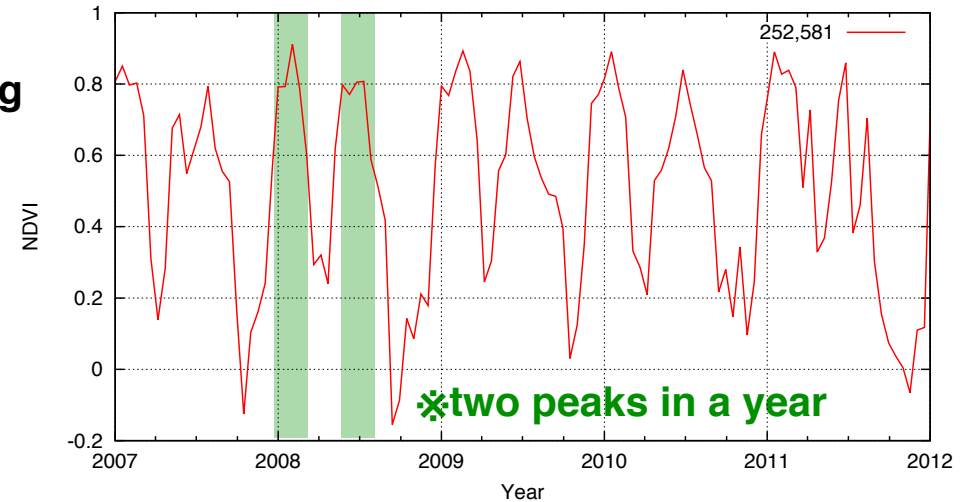
# Crop Calendar Identification from Time-series NDVI

## Chao Phraya River Basin, Thailand

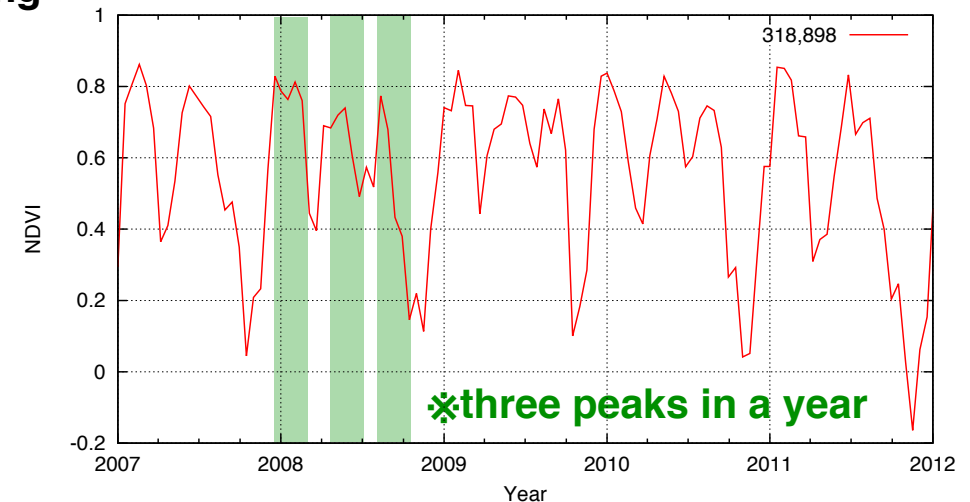


## Time-series NDVI (MOD13Q1)

### Double Cropping (P1)



### Triple Cropping (P2)



High-frequent observation data are useful to identify crop calendars.

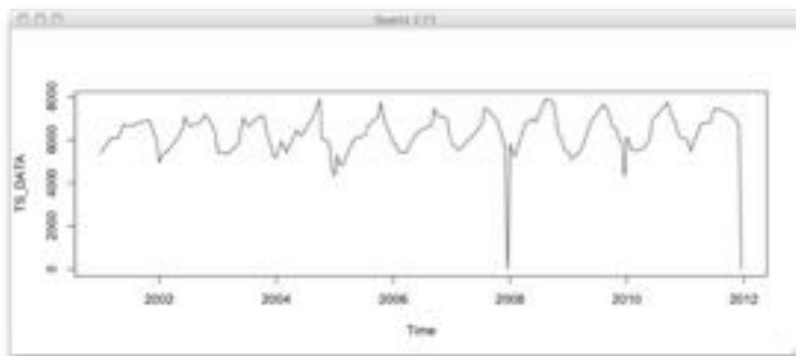
# Crop Calendar Estimation using Spectrum Analysis

- Applying Discrete Fourier Transform (DFT) to time-series Vegetation Index

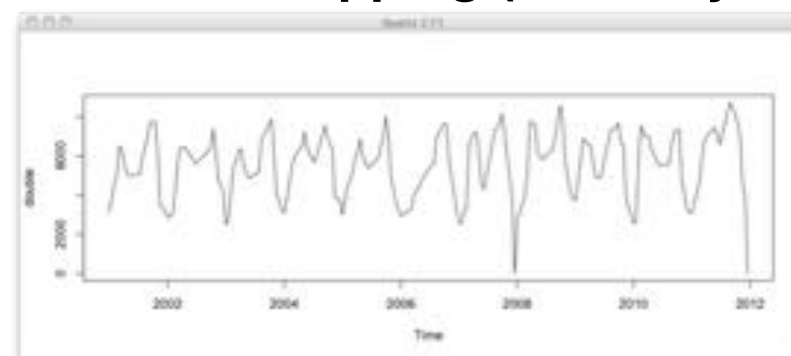
**Fourier  
Transform**

$$X(k) = \sum_{n=0}^{N-1} x(n)e^{-j\frac{2\pi}{N}kn}$$

**Single Cropping (once a year)**

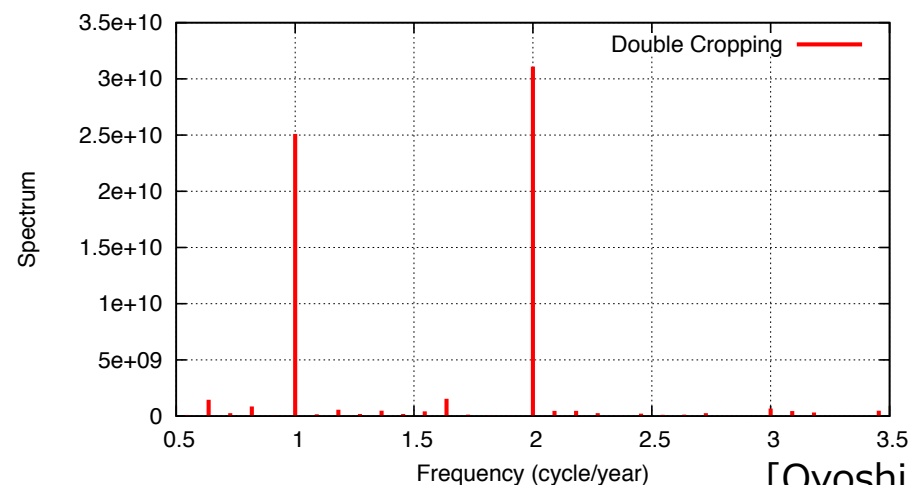
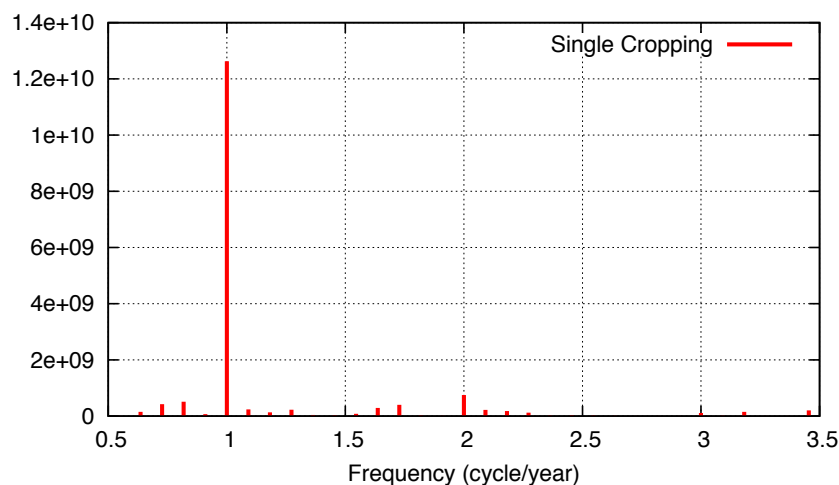


**Double Cropping (twice a year)**



**MODIS NDVI**

**Power Spectrum**



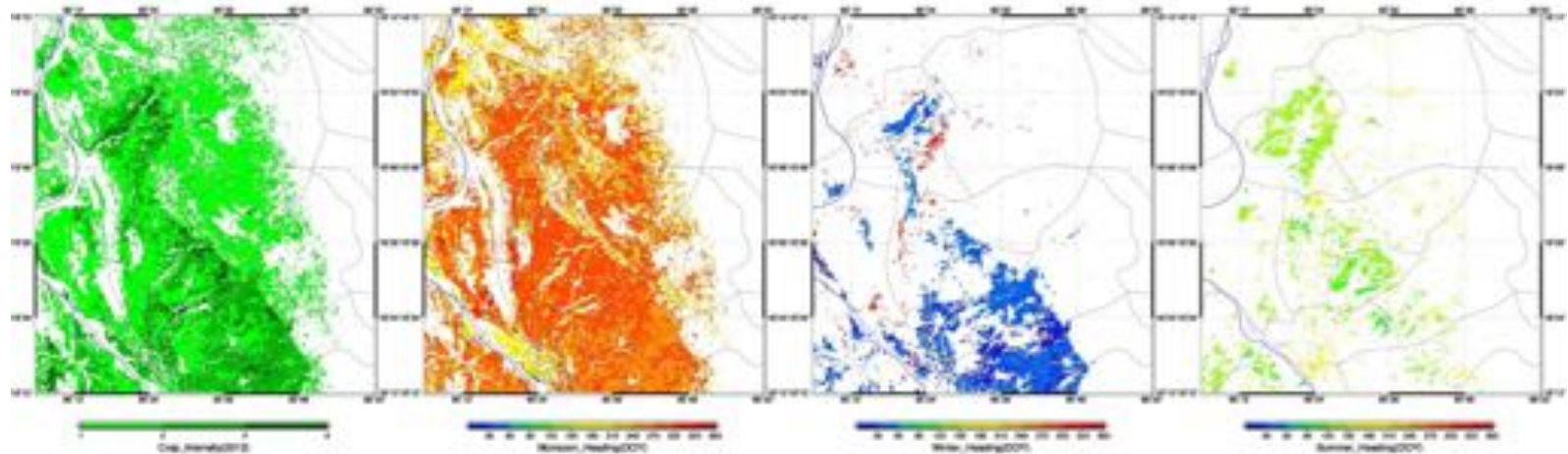
[Oyoshi, 2013]

**Frequency with highest spectrum would be crop intensity of each pixel.**

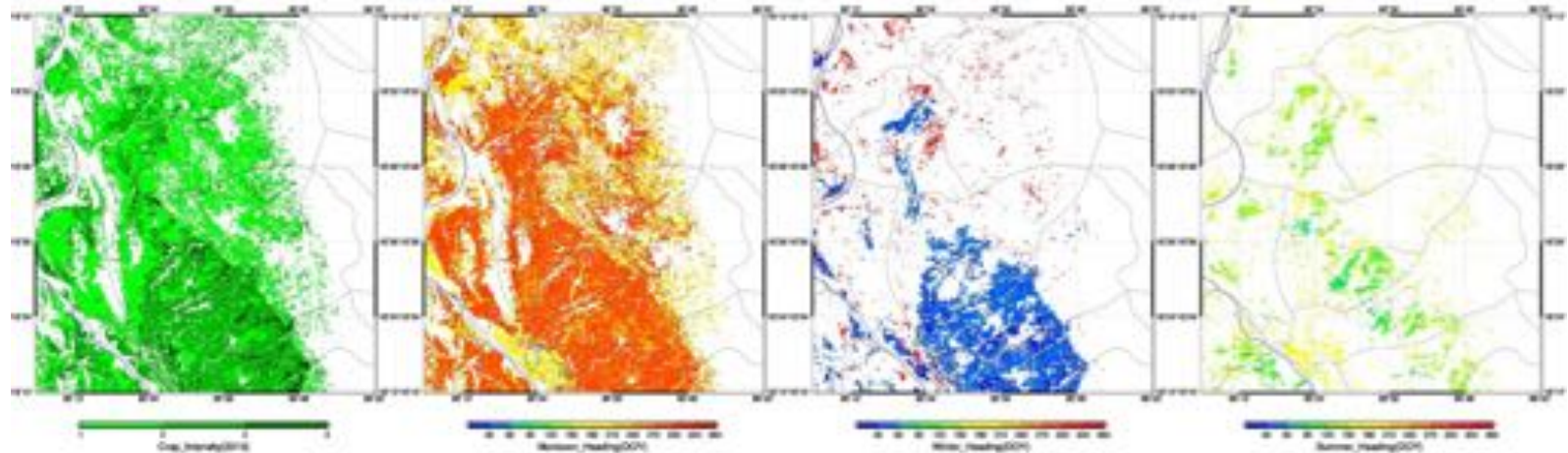
# Crop Calendar in West Bago Region, Myanmar

**Crop Intensity**      **Monsoon**      **Winter (Dry)**      **Summer**  
 Date of Maximum NDVI      Date of Maximum NDVI      Date of Maximum NDVI

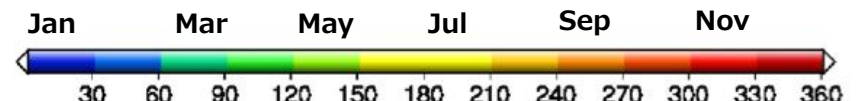
2012/2013



2013/2014



Crop Intensity (cropping /year)

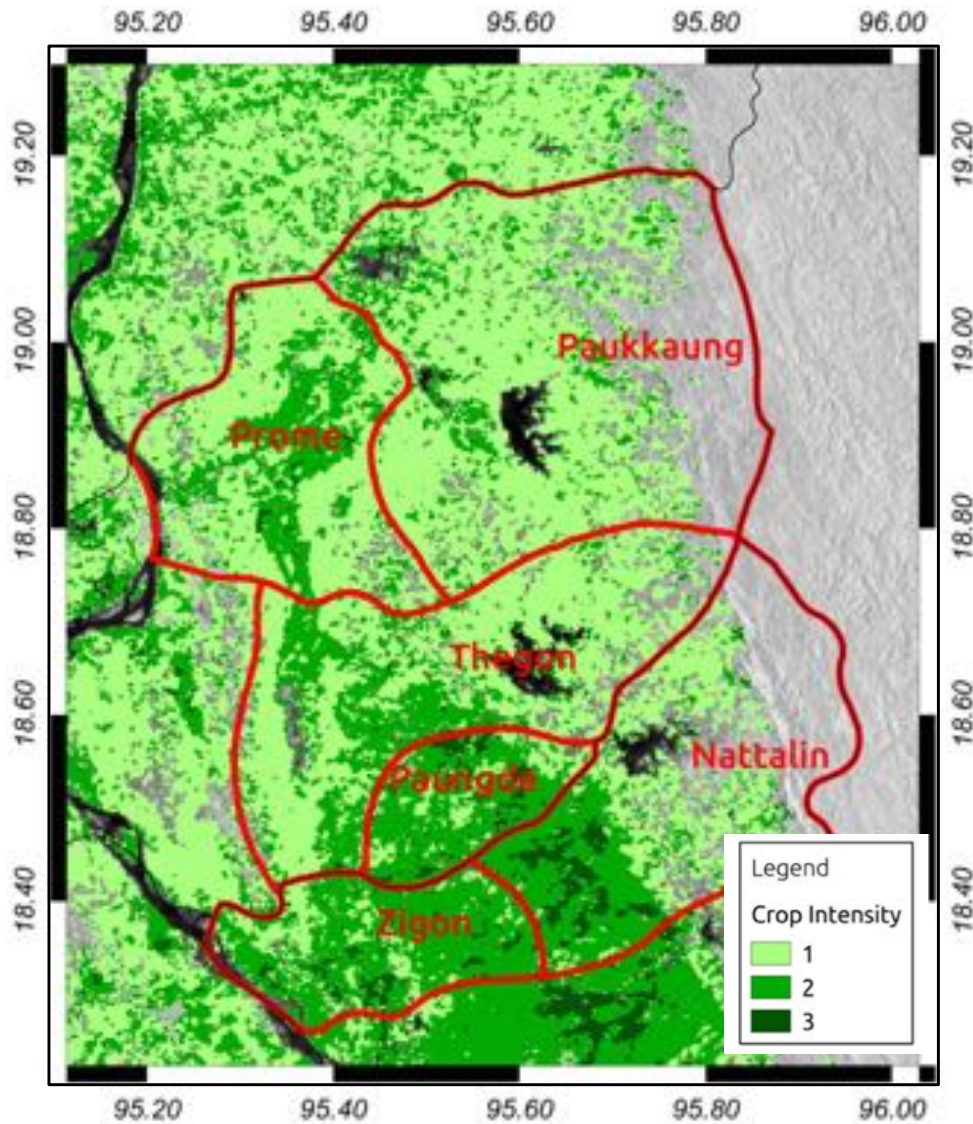


Maximum NDVI (DOY: Days of Year)

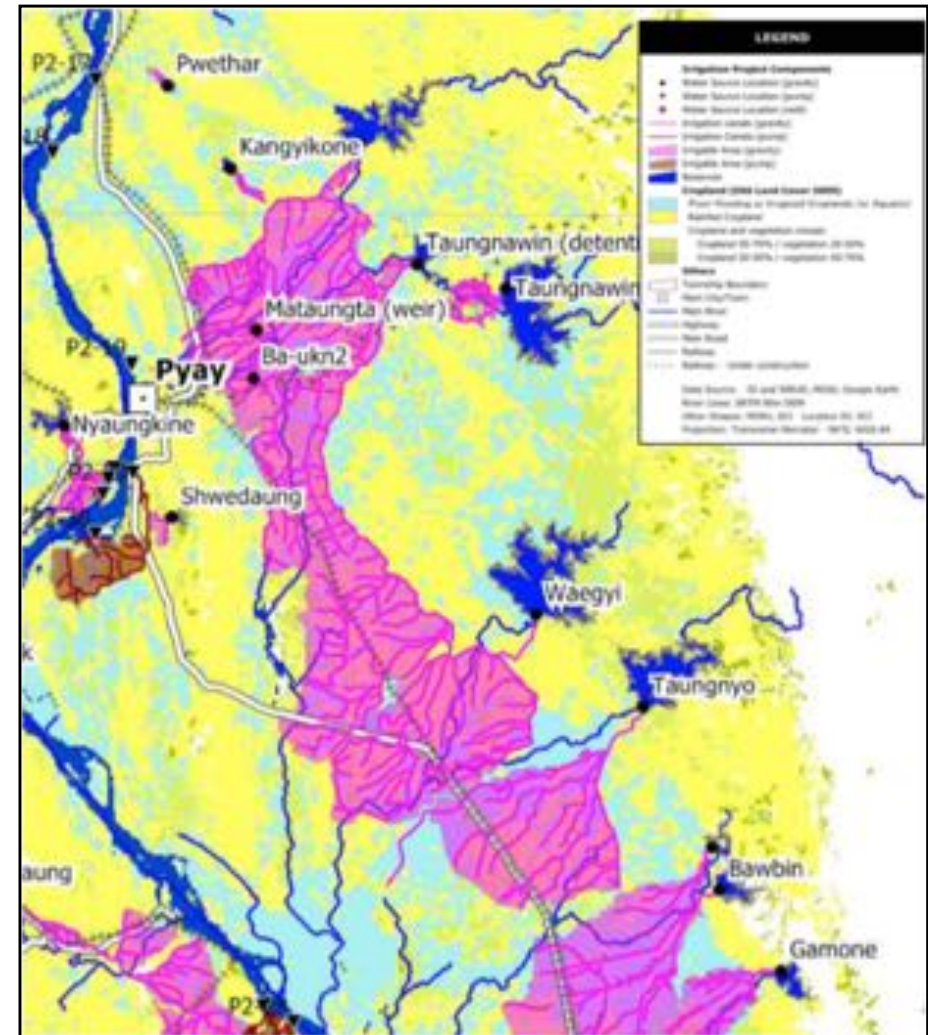


# Comparison with Existing Irrigation Map

## Crop Intensity (2011)



## Irrigation Map (JICA)



※Pink: Irrigation Area



# Identification of Changes in Crop Calendar

## • Study Area

- Rajasthan, India
- Minor irrigation improvement project (2005-2015)
- Widely distributed

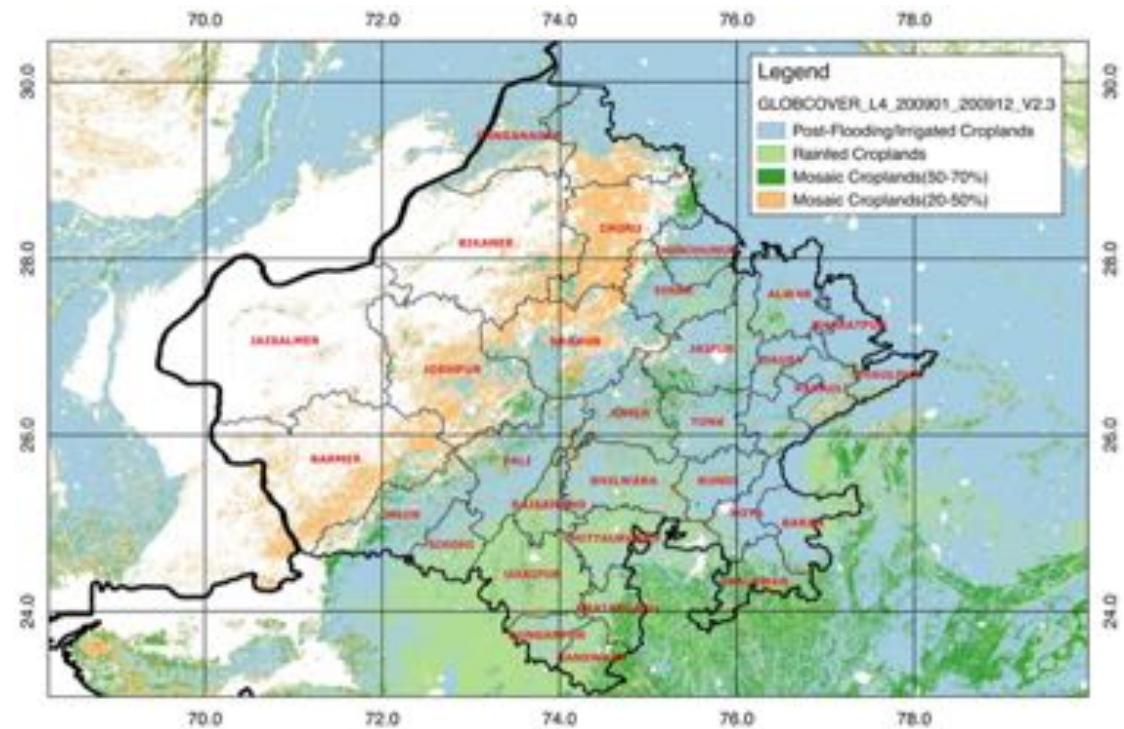


## • Satellite data

- MODIS 16-day composite data (MOD13Q1)

## • Output Data

- Crop calendar (before/after the project)

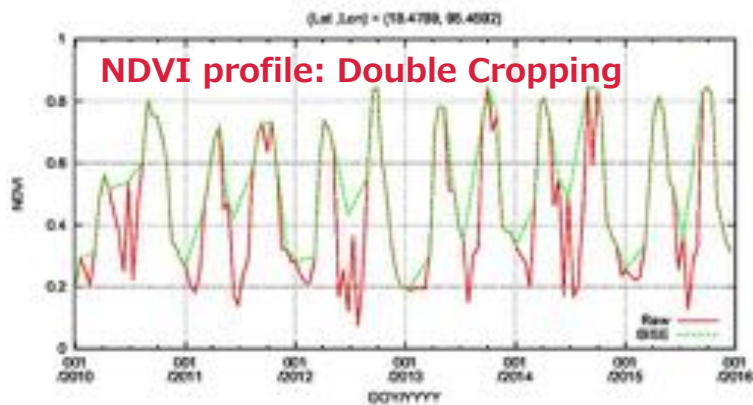
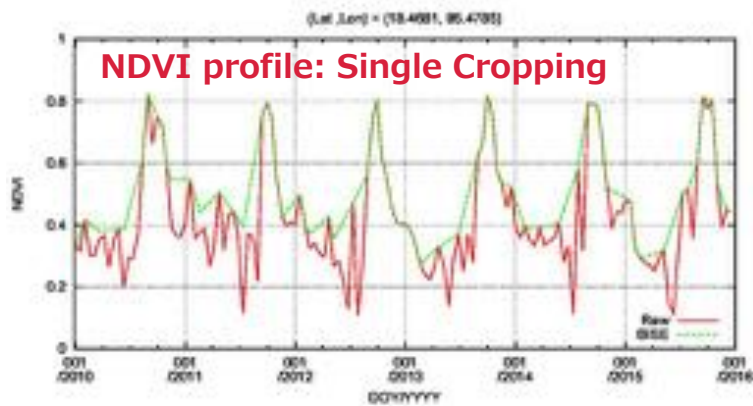


[ESA GlobeCover2009]

900 km

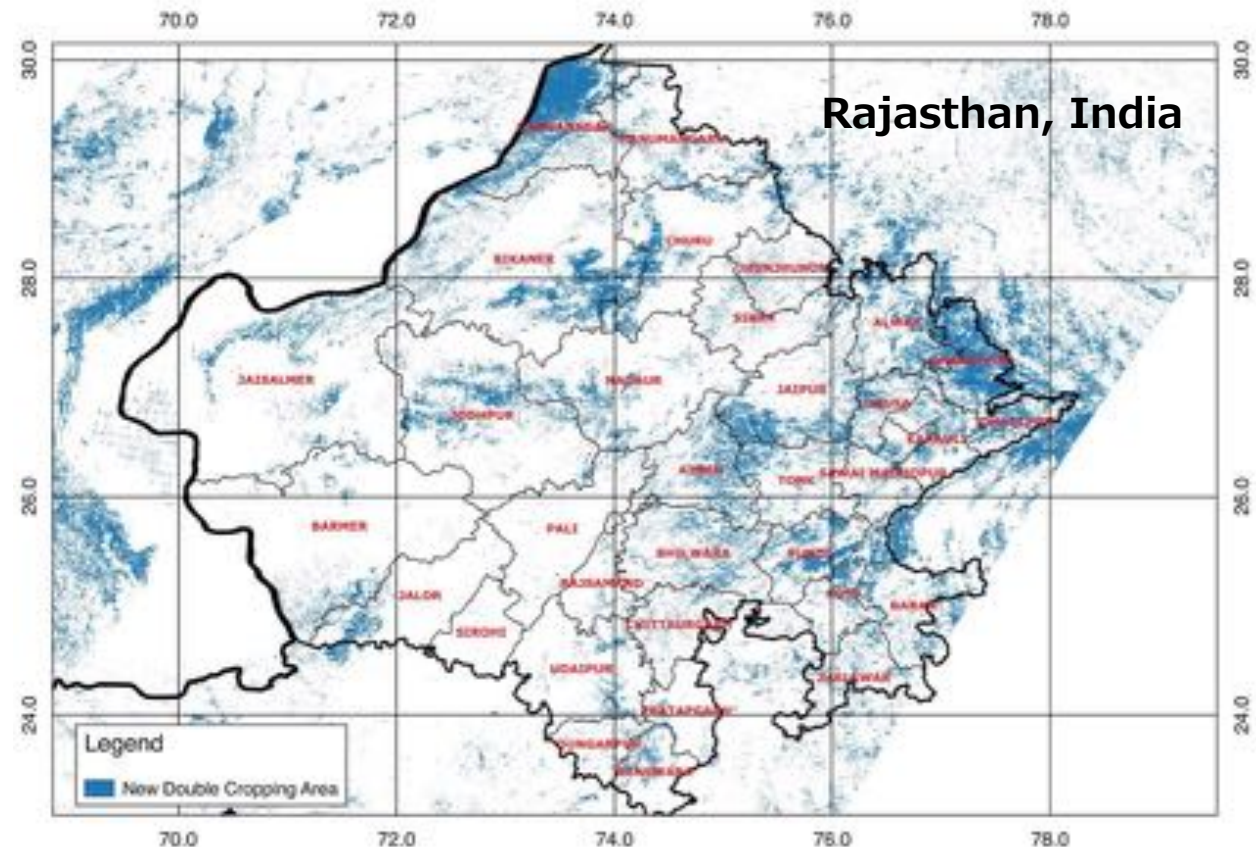
# Identification of Cropping Intensity Changed Area

- Changed area are identified from the crop calendar in 2002 to 2004 and 2014 to 2016.



※Green Line : applying time-series filter

**Crop intensity identification by spectrum analysis**



**Cropping Intensity Change (single to double) (2002-2004 vs 2014-2016)**

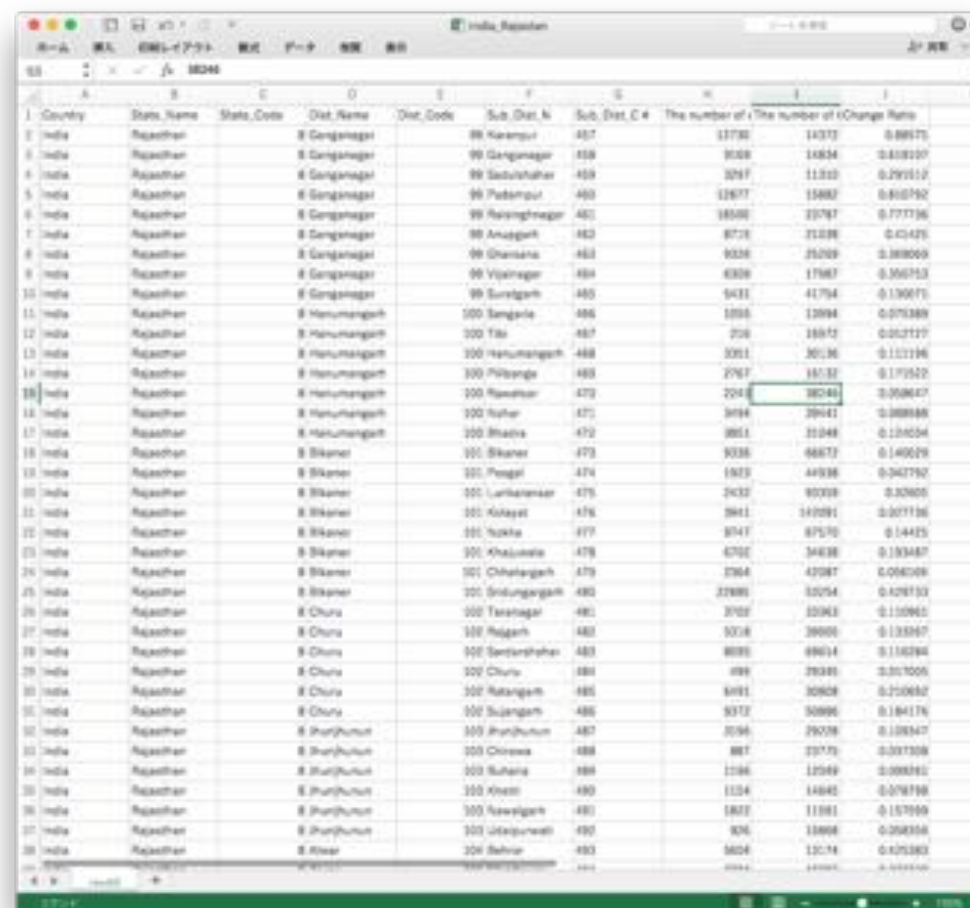


# Output Data Utilized in JICA

- JICA utilized output data in efficient site selections for field survey to confirm the project effect over huge study area (800 x 500km).



**KML format**



Country	State Name	State Code	Dist Name	Dist Code	Sub-Dist. N	Sub-Dist. C	The number of i	The number of r	Change Rate
India	Rajasthan	8	Ganganagar	88	Kanpur	457	11780	14372	0.88970
India	Rajasthan	8	Ganganagar	88	Ganganagar	458	3008	18834	0.618200
India	Rajasthan	8	Ganganagar	88	Sachinwaha	459	3297	11320	0.791512
India	Rajasthan	8	Ganganagar	88	Padampur	460	12677	15882	0.802762
India	Rajasthan	8	Ganganagar	88	Rajsamand	461	18000	22787	0.777736
India	Rajasthan	8	Ganganagar	88	Anugarth	462	8728	21038	0.45426
India	Rajasthan	8	Ganganagar	88	Chimsara	463	6338	25209	0.288009
India	Rajasthan	8	Ganganagar	88	Vijainagar	464	6309	17987	0.350713
India	Rajasthan	8	Ganganagar	88	Surgarth	465	5431	41794	0.130070
India	Rajasthan	8	Hanumangarh	100	Sangala	466	1096	10994	0.075389
India	Rajasthan	8	Hanumangarh	100	Til	467	278	18872	0.012127
India	Rajasthan	8	Hanumangarh	100	Hanumangarh	468	3211	30736	0.112194
India	Rajasthan	8	Hanumangarh	100	Pilangla	469	2767	16732	0.175620
India	Rajasthan	8	Hanumangarh	100	Ranwar	470	2244	30480	0.098437
India	Rajasthan	8	Hanumangarh	100	Rohar	471	3894	29441	0.088888
India	Rajasthan	8	Hanumangarh	100	Sharda	472	3811	21048	0.184054
India	Rajasthan	8	Bikaner	101	Bikaner	473	9338	68872	0.140029
India	Rajasthan	8	Bikaner	101	Pongli	474	1823	44938	0.040792
India	Rajasthan	8	Bikaner	101	Lunkarner	475	2432	92008	0.02680
India	Rajasthan	8	Bikaner	101	Kokraj	476	3641	142991	0.027136
India	Rajasthan	8	Bikaner	101	Jukha	477	8747	87570	0.14425
India	Rajasthan	8	Bikaner	101	Khalasala	478	4702	34838	0.133487
India	Rajasthan	8	Bikaner	101	Chhatargarh	479	2364	42887	0.056209
India	Rajasthan	8	Bikaner	101	Sridungargarh	480	22991	32574	0.428733
India	Rajasthan	8	Churu	102	Tarangarh	481	3702	20943	0.176962
India	Rajasthan	8	Churu	102	Palgarh	482	5278	38900	0.133507
India	Rajasthan	8	Churu	102	Santoshnagar	483	8891	68014	0.130284
India	Rajasthan	8	Churu	102	Churu	484	499	29340	0.017008
India	Rajasthan	8	Churu	102	Palangarh	485	6491	38088	0.170862
India	Rajasthan	8	Churu	102	Sujanagar	486	8372	58896	0.184178
India	Rajasthan	8	Bharatpur	103	Bharatpur	487	2094	29278	0.08847
India	Rajasthan	8	Bharatpur	103	Chimsa	488	887	22770	0.393708
India	Rajasthan	8	Bharatpur	103	Buhana	489	1286	12589	0.088912
India	Rajasthan	8	Bharatpur	103	Khatli	490	1124	14842	0.078798
India	Rajasthan	8	Bharatpur	103	Rawigarh	491	1827	11981	0.157009
India	Rajasthan	8	Bharatpur	103	Udaipurwadi	492	826	18868	0.043004
India	Rajasthan	8	Bharatpur	103	Behar	493	5024	12078	0.025383

**CSV format**

(changed areas in sub-district unit)



# Summary

- Time-series and local-scale crop calendar developed from satellite data can capture the improvement of water resource availability by irrigation project.
- JICA and JAXA have collaboration to utilize satellite-based observation data for the evaluation of irrigation project.
- Crop calendar created from time-series NDVI data were utilized in JICA irrigation project to select the sites for site survey and JICA confirmed that the data can support efficient site selections.
- JICA-JAXA new collaboration has been started for planted-area and crop calendar mapping using every 14-day observation ALOS-2 data with 6m spatial resolution towards ALOS-4 utilization for irrigation project evaluations.

Thank you very much for your attention.

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