



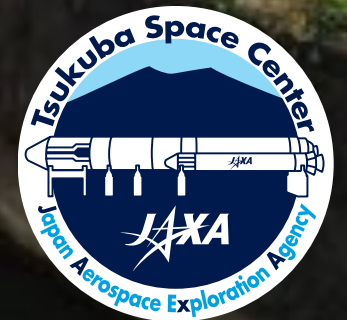
Identification of Crop Calendar Using Satellite Data for Evaluation of Irrigation Project by JICA

Kei Oyoshi, Shinichi Sobue

Japan Aerospace Exploration Agency (JAXA)

11th AEOGSS Asia Pacific Symposium

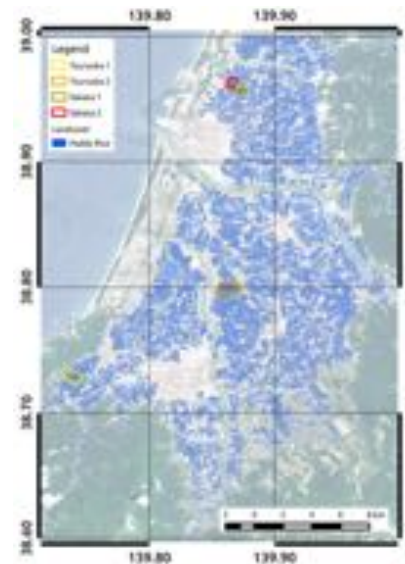
**@Kyoto, Japan
24-26 October 2018**



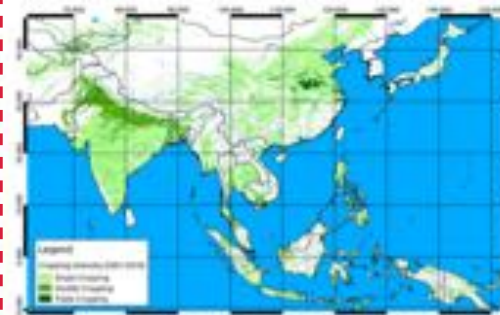
Asia-RiCE: Agriculture-Related Products

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

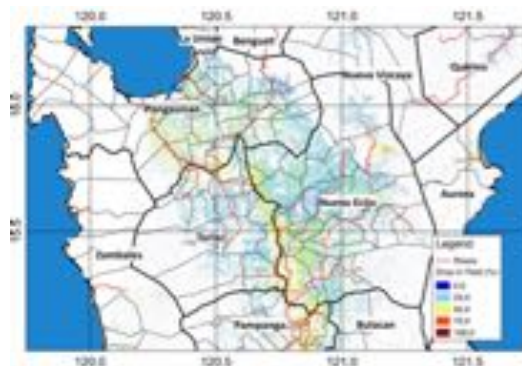
Product Examples



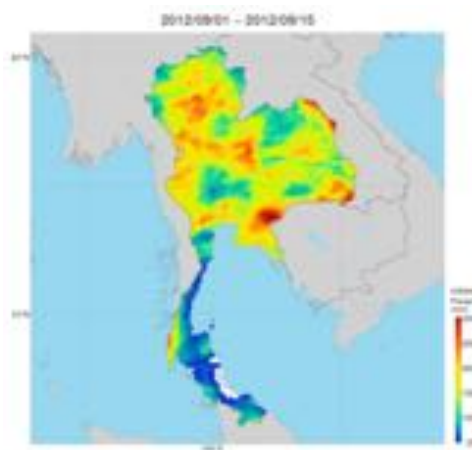
P1: Planted Area



P2: Crop Calendar



P3: Crop Damage



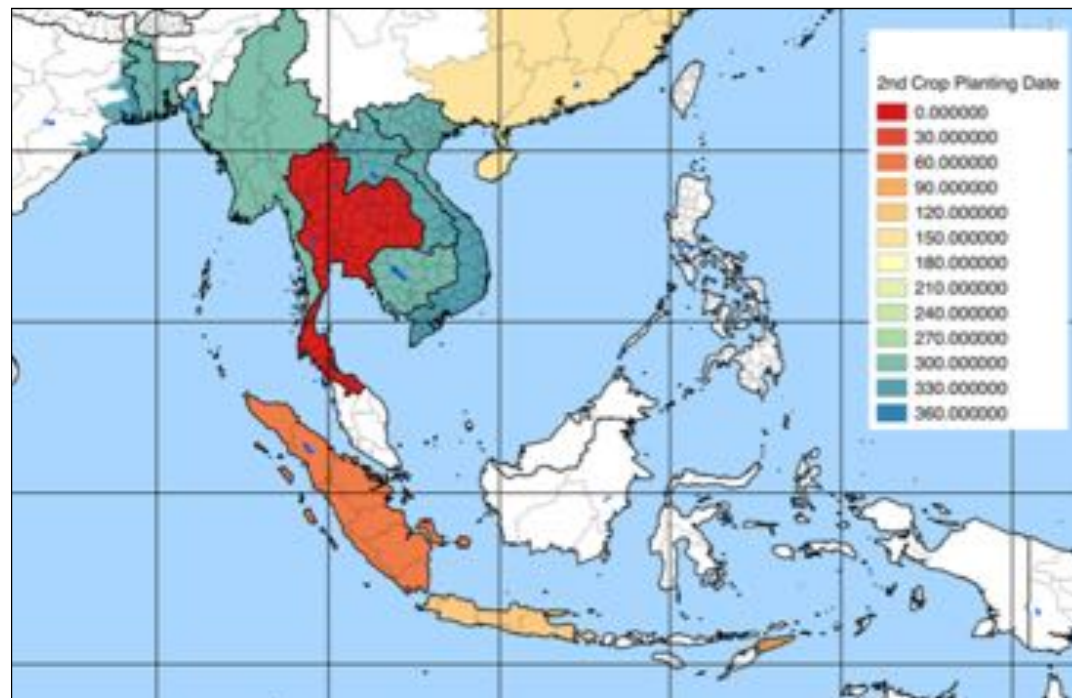
P4: Precipitation

<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]

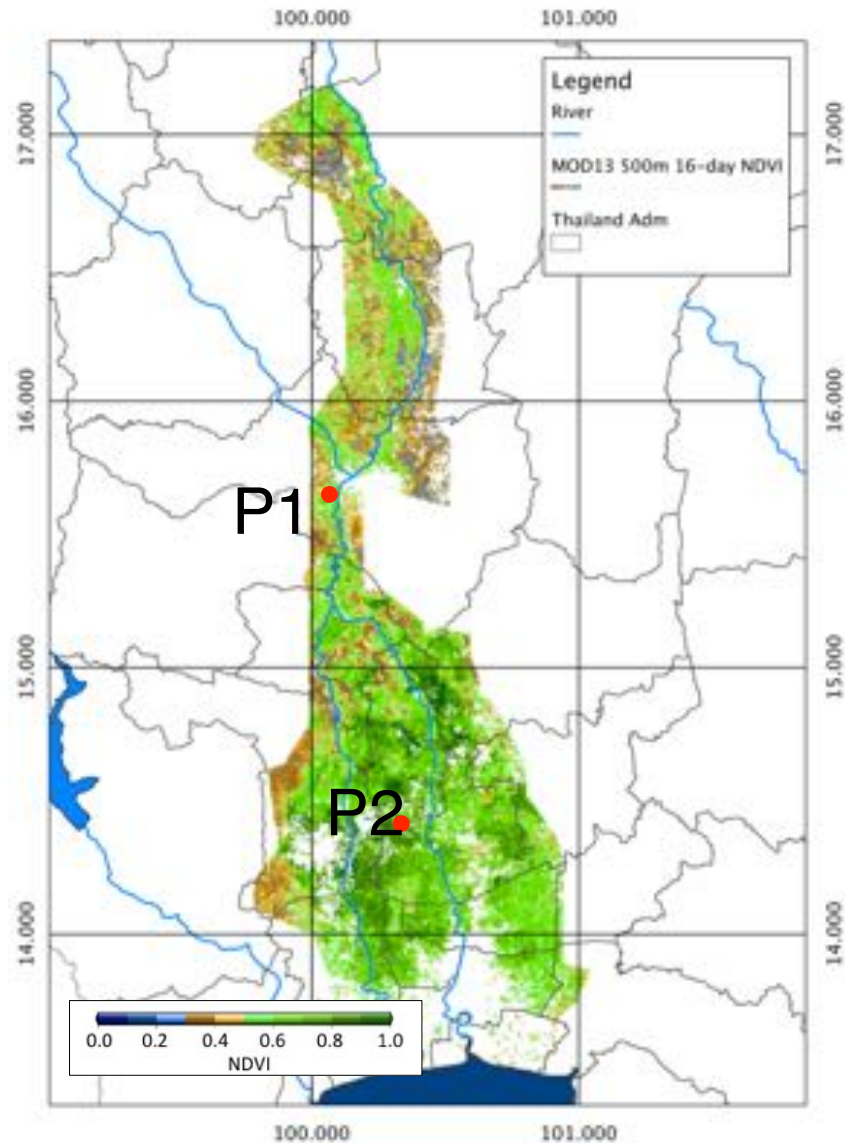
Utilization of Crop Calendar in JICA Irrigation Project

- 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.

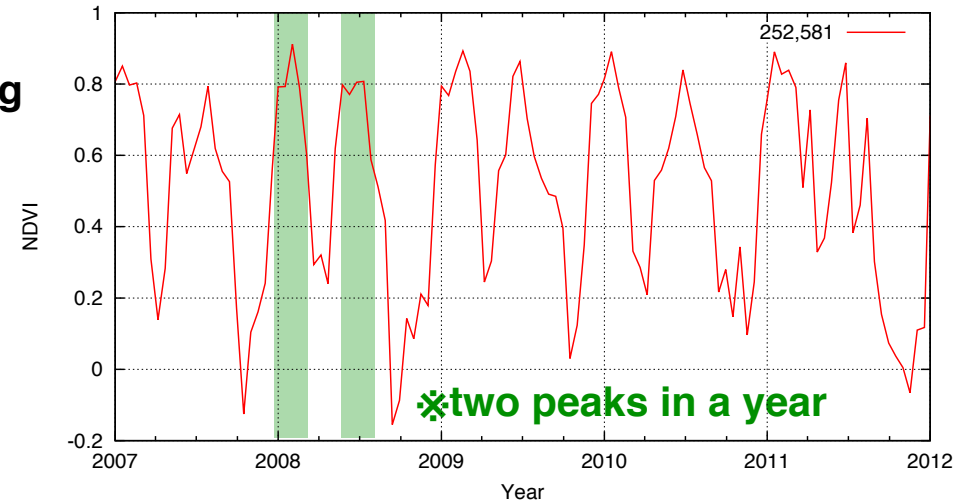
Crop Calendar Identification from Time-series NDVI

Chao Phraya River Basin, Thailand

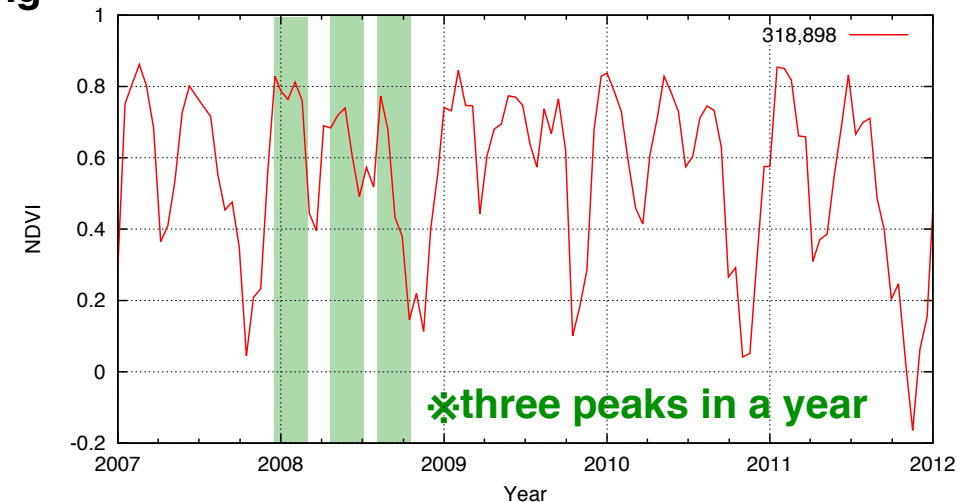


Time-series NDVI (MOD13Q1)

Double Cropping (P1)



Triple Cropping (P2)



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

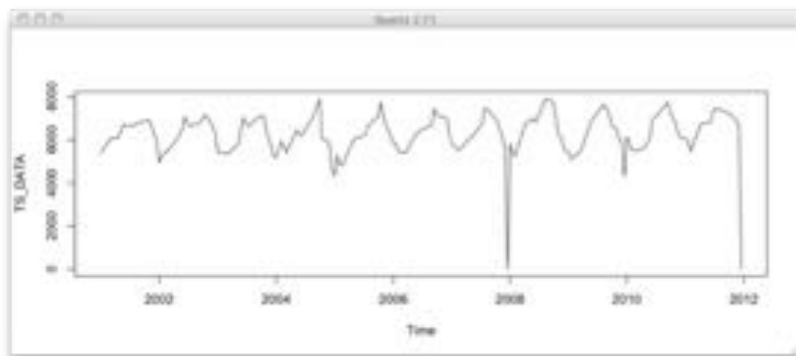
Crop Calendar Estimation using Spectrum Analysis

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

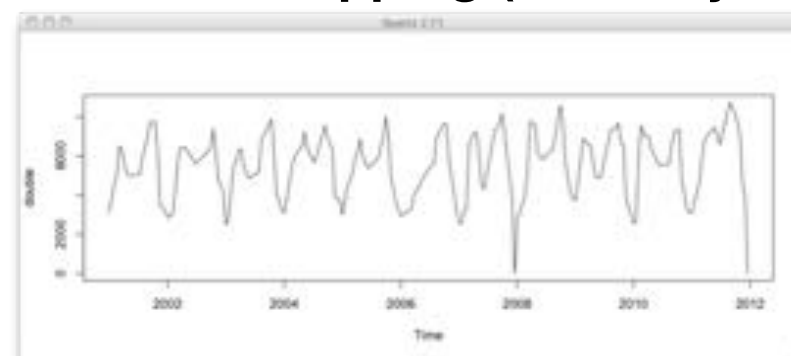
**Fourier
Transform**

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

Single Cropping (once a year)

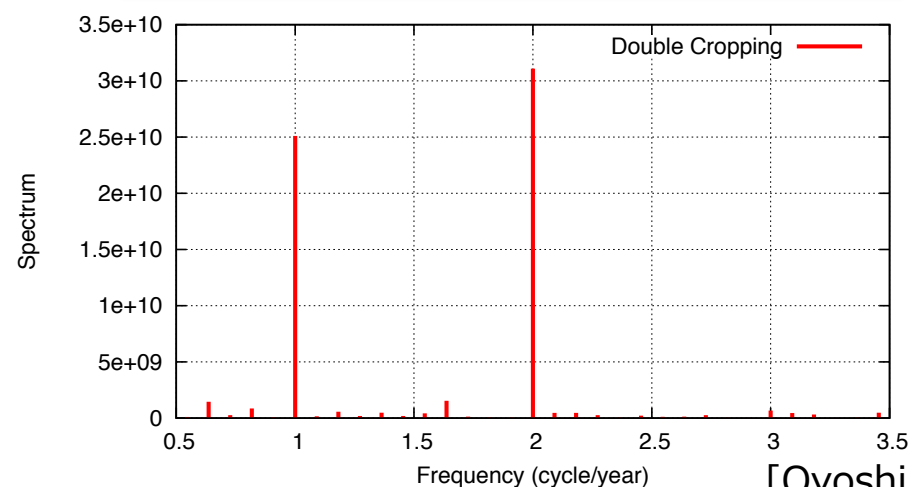
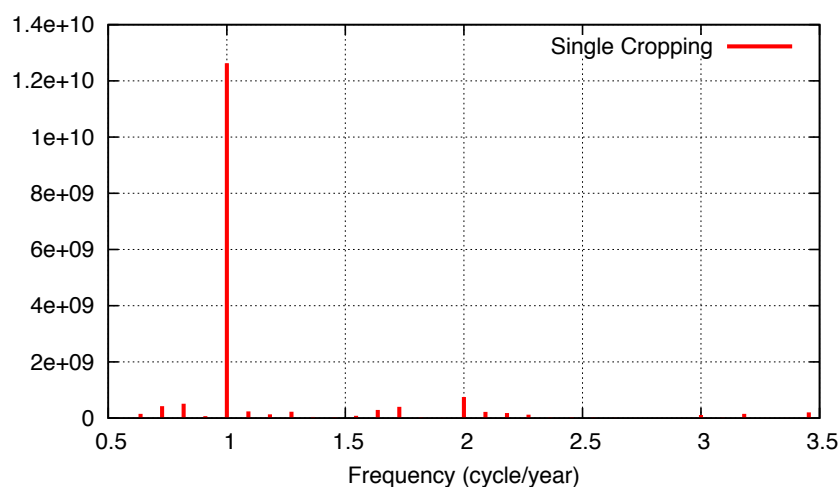


Double Cropping (twice a year)



MODIS NDVI

Power Spectrum



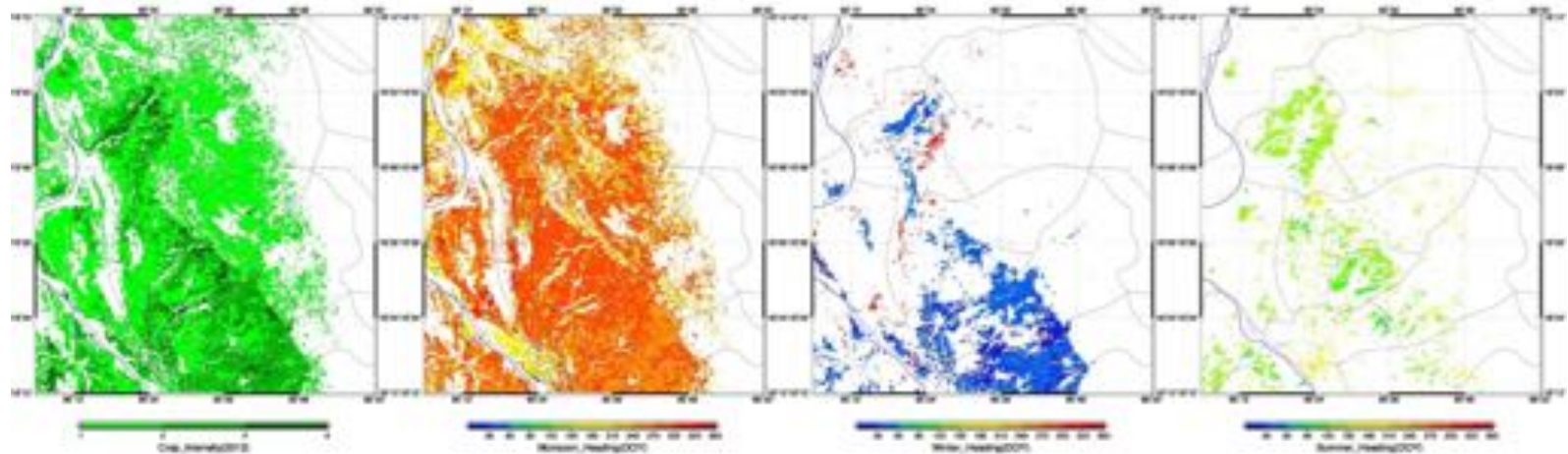
[Oyoshi, 2013]

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

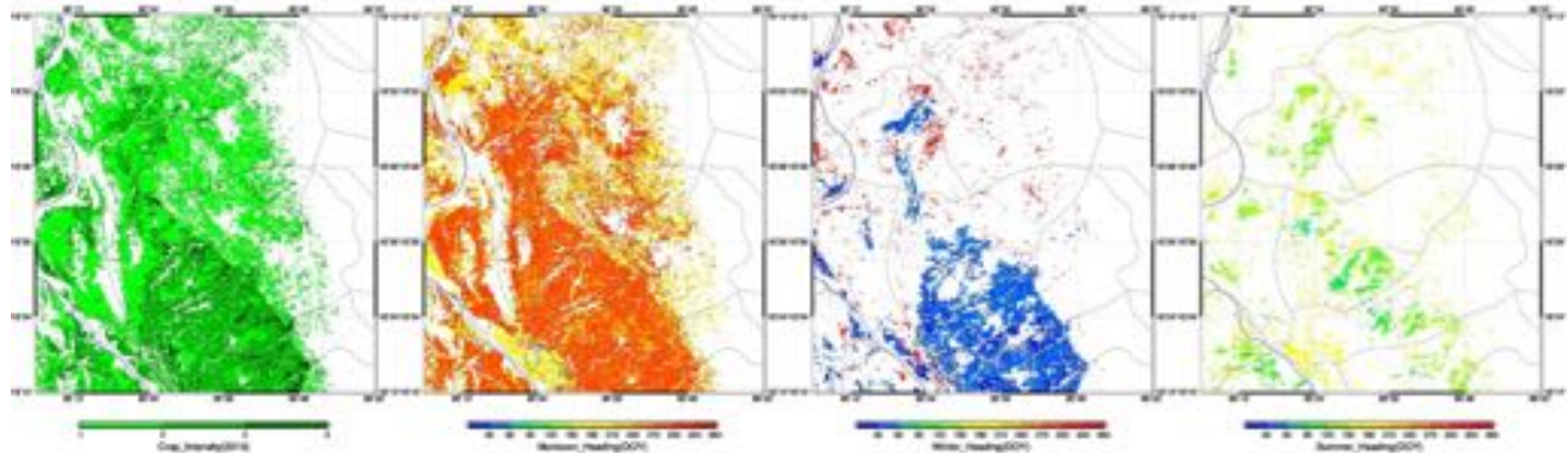
Crop Calendar in West Bago Region, Myanmar

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

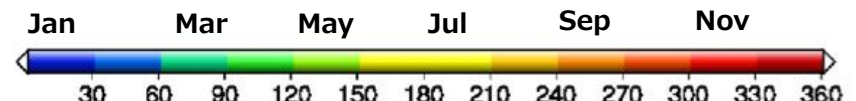
2012/2013



2013/2014



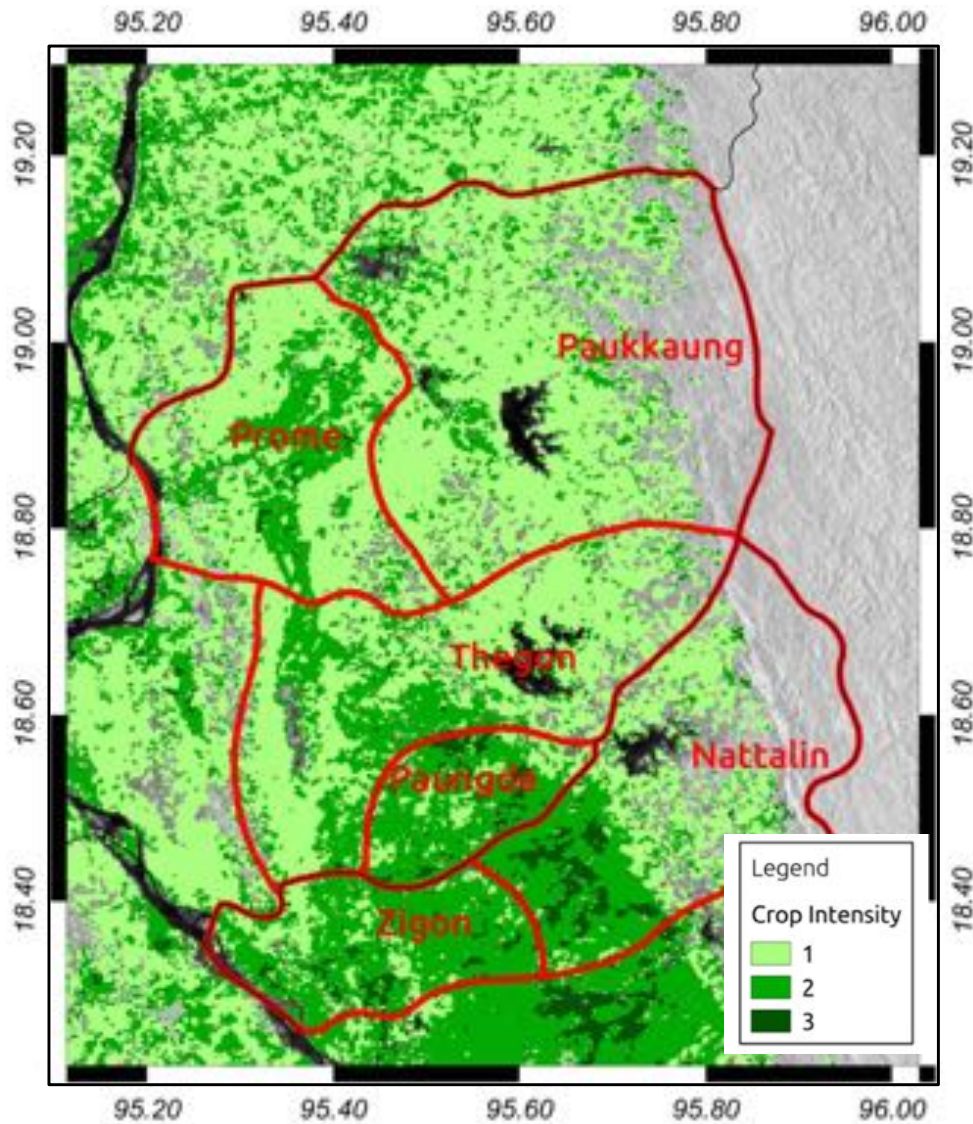
Crop Intensity (cropping /year)



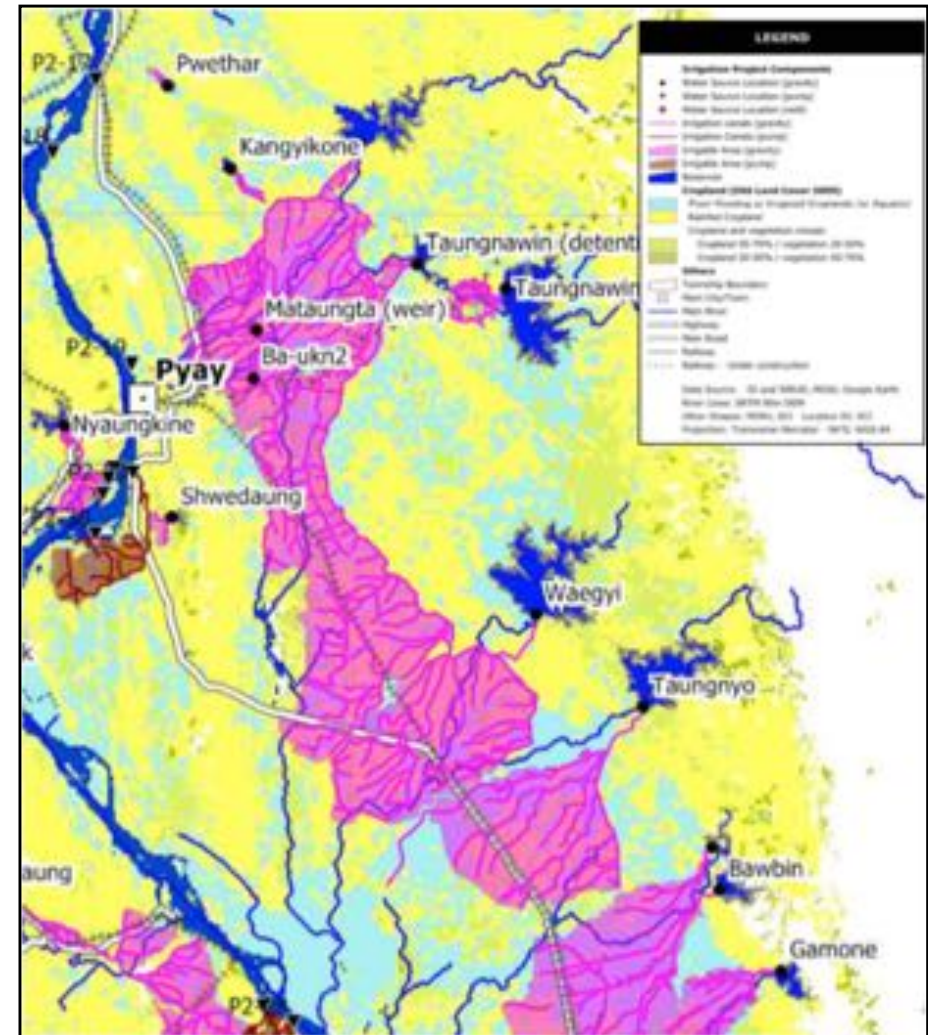
Maximum NDVI (DOY: Days of Year)

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

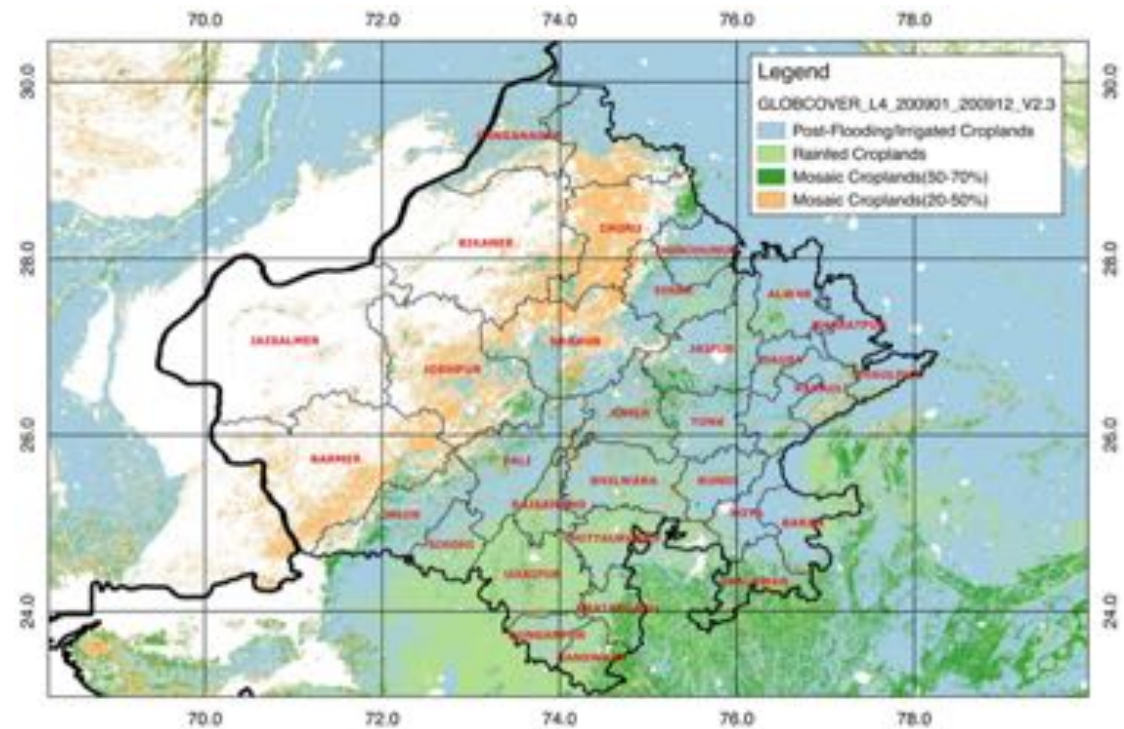


• Satellite data

- MODIS 16-day composite data (MOD13Q1)

• Output Data

- Crop calendar (before/after the project)

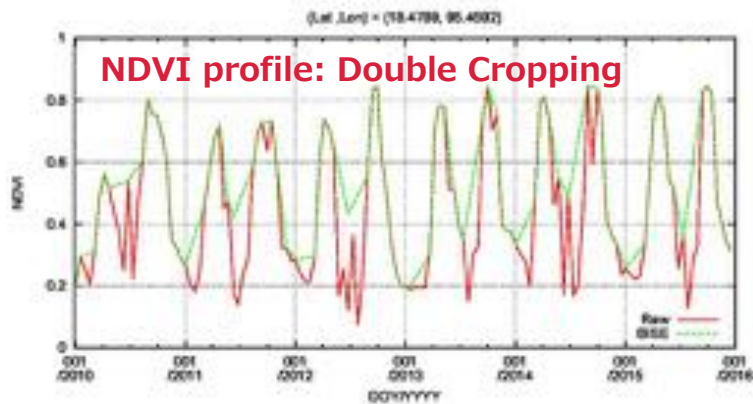
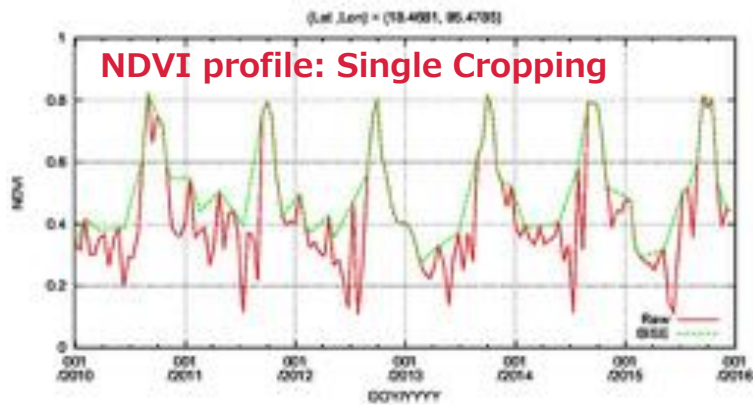


[ESA GlobeCover2009]

900 km

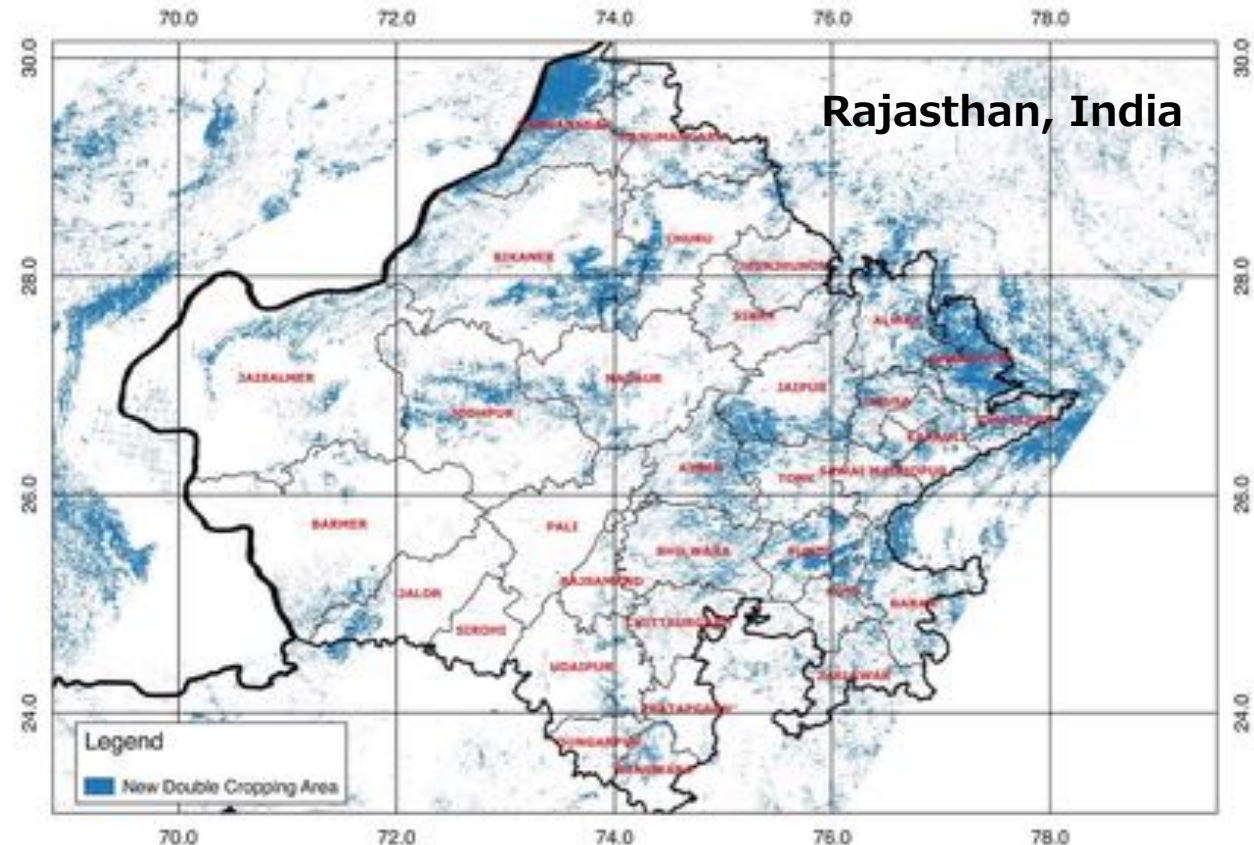
Identification of Cropping Intensity Changed Area

- 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 t	Change Rate
India	Rajasthan	8	Ganganagar	88	Kanpur	457	11730	14372	0.88970
India	Rajasthan	8	Ganganagar	88	Ganganagar	458	3008	14834	0.481200
India	Rajasthan	8	Ganganagar	88	Sachinbhai	459	3297	11210	0.791512
India	Rajasthan	8	Ganganagar	88	Padampur	460	12677	15882	0.802762
India	Rajasthan	8	Ganganagar	88	Risinghpagar	461	18500	22787	0.777736
India	Rajasthan	8	Ganganagar	88	Anugarth	462	8728	21038	0.45425
India	Rajasthan	8	Ganganagar	88	Chansara	463	6338	25209	0.288009
India	Rajasthan	8	Ganganagar	88	Vijaynagar	464	6309	17987	0.350713
India	Rajasthan	8	Ganganagar	88	Surgarth	465	5431	41704	0.130070
India	Rajasthan	8	Hanumangarh	100	Sangola	466	1898	10994	0.075389
India	Rajasthan	8	Hanumangarh	100	Til	467	270	18872	0.021217
India	Rajasthan	8	Hanumangarh	100	Hanumangarh	468	3211	30736	0.112196
India	Rajasthan	8	Hanumangarh	100	Phangla	469	2767	18732	0.175620
India	Rajasthan	8	Hanumangarh	100	Ranchar	470	224	3048	0.096437
India	Rajasthan	8	Hanumangarh	100	Kolar	471	3894	29441	0.388988
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	0.047792
India	Rajasthan	8	Bikaner	101	Lunkarner	475	2432	92018	0.26805
India	Rajasthan	8	Bikaner	101	Kokray	476	3641	14291	0.207136
India	Rajasthan	8	Bikaner	101	Sukla	477	8747	87570	0.14425
India	Rajasthan	8	Bikaner	101	Khalawala	478	4702	34838	0.193487
India	Rajasthan	8	Bikaner	101	Chhatargarh	479	2364	42087	0.060209
India	Rajasthan	8	Bikaner	101	Sridungargarh	480	22981	32054	0.428733
India	Rajasthan	8	Churu	102	Tarangarh	481	3702	20943	0.170961
India	Rajasthan	8	Churu	102	Palgarh	482	5278	38900	0.133267
India	Rajasthan	8	Churu	102	Saranshpahar	483	8891	68014	0.116284
India	Rajasthan	8	Churu	102	Churu	484	499	29340	0.207005
India	Rajasthan	8	Churu	102	Ratangarh	485	6481	3808	0.210682
India	Rajasthan	8	Churu	102	Sujanagar	486	8372	58896	0.184178
India	Rajasthan	8	Bharatpur	103	Bharatpur	487	2094	29278	0.18847
India	Rajasthan	8	Bharatpur	103	Chiroda	488	887	22775	0.397308
India	Rajasthan	8	Bharatpur	103	Buhana	489	1286	12549	0.088312
India	Rajasthan	8	Bharatpur	103	Khatli	490	1124	14842	0.078738
India	Rajasthan	8	Bharatpur	103	Rawigarh	491	1827	11981	0.157009
India	Rajasthan	8	Bharatpur	103	Udaipurwati	492	826	18868	0.288304
India	Rajasthan	8	Bharatpur	103	Behar	493	5024	12078	0.252882

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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