Quantifying Changes in Agricultural Intensification, Expansion and Loss in Monsoon Asia in 2000-2010

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Indonesia	Institute of Technology Bandung: Ketut Wilkantika,
	World Agroforestry Center (ICRAF): Jianchu Xu
Thailand:	Asian Institute of Technology: Manzul Hazarika, Nalin enevirathne
Vietnam:	Vietnam Academy of Sciences and Technology: Lam Dao Nguyen, Nguyen Dinh Duong

Human population density in Monsoon Asia

- More than half of the world's population (7 billions in 2011) live in monsoon Asia.

Who will feed monsoon Asia?

Agricultural intensification, expansion and loss

Cropland area

Cropping intensity

number of crops per year in a farm field

Single, double and triple

Crop calendar and phenology

planting date, green-up date, harvest date

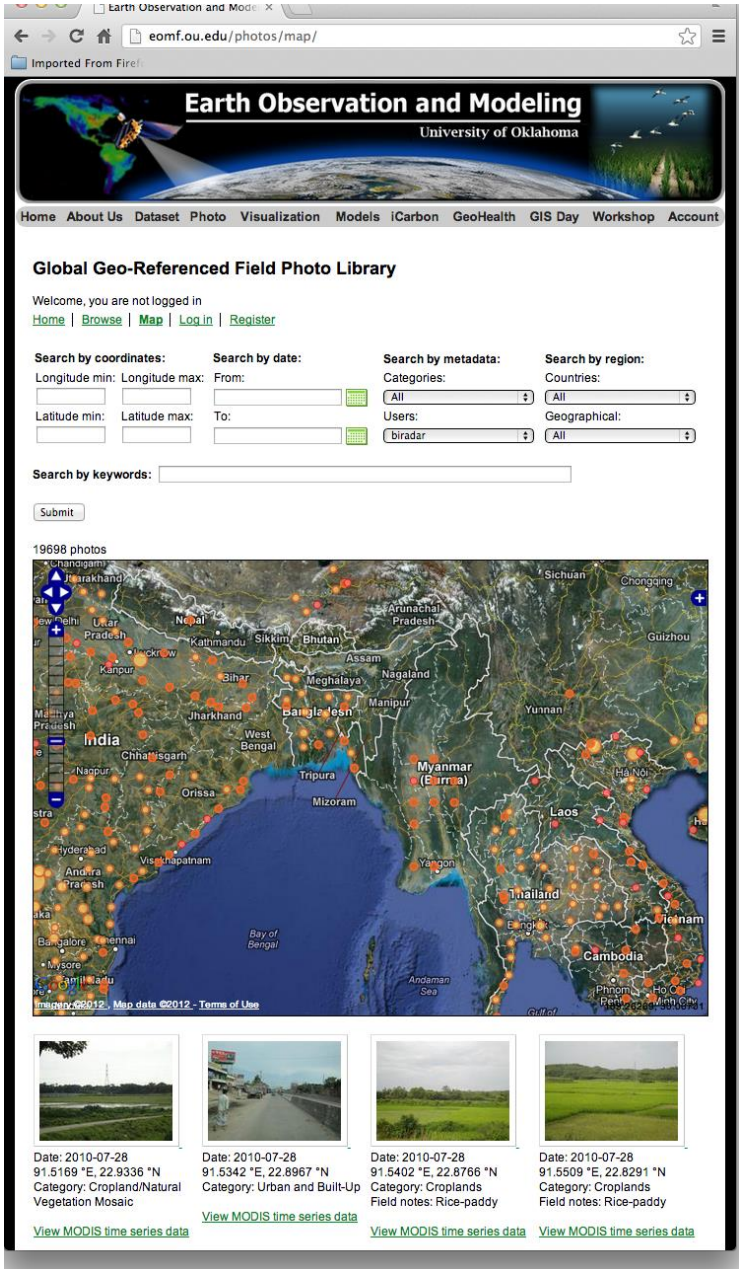
Crop management

irrigation, inundation, fertilization, no-tillage

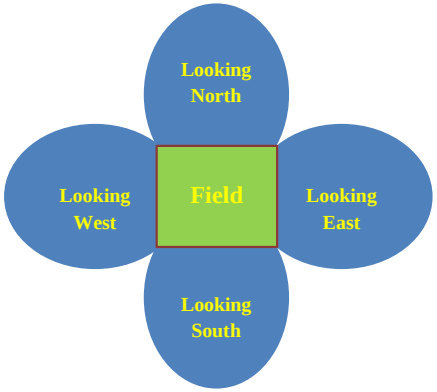
Crop type

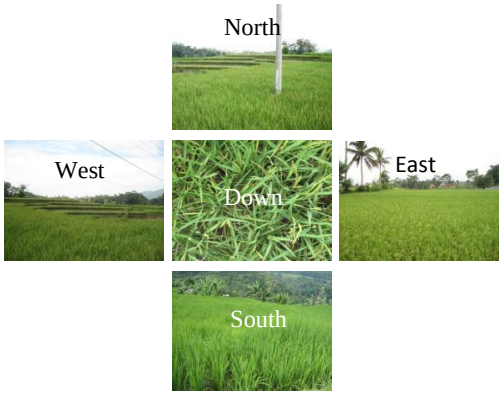
paddy rice, winter wheat, spring wheat, maize, soybean

Geo-Referenced Field Photo Library

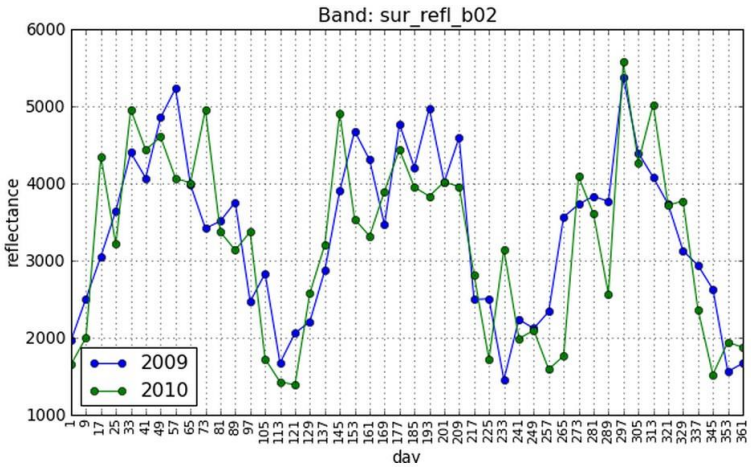


Protocol for taking photos in the field





Individual photos are linked with time series MODIS data (2000-present)



Cropping intensity

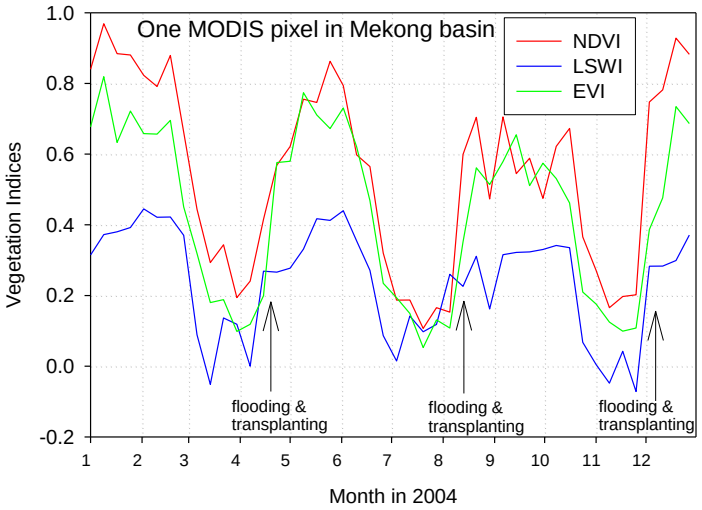
Time series MODIS imagery

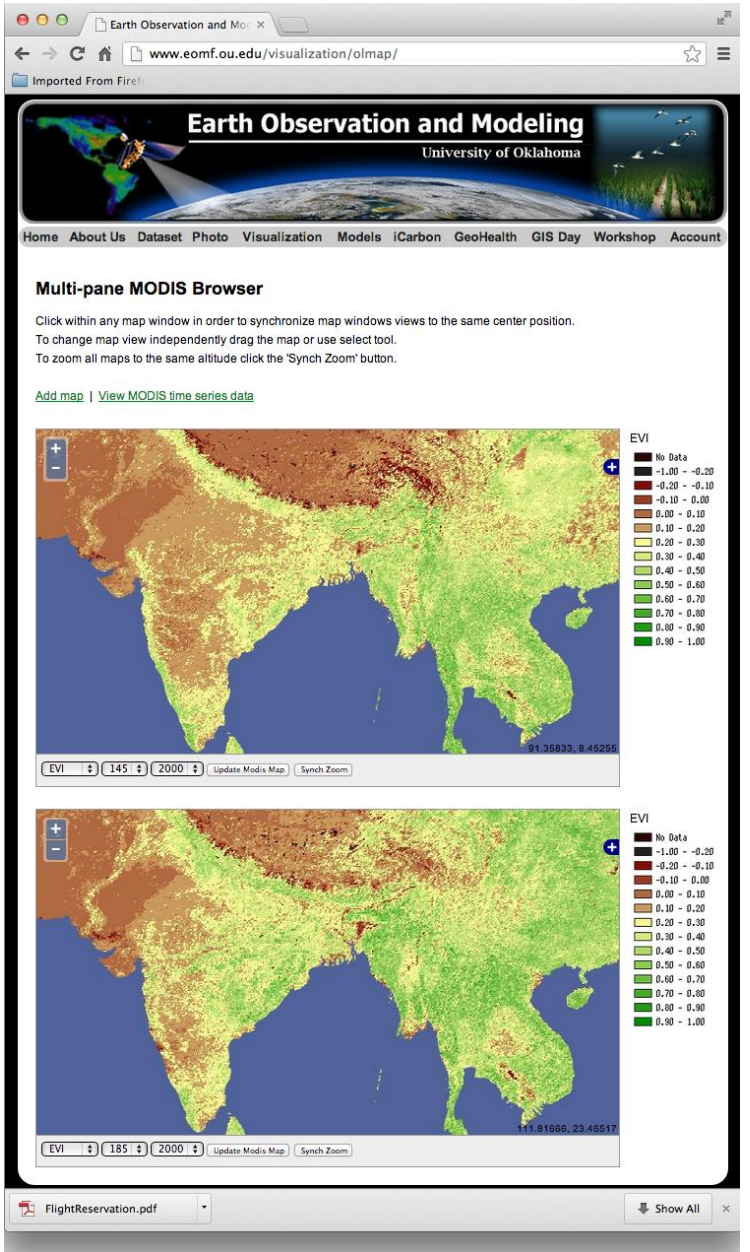
Surface reflectance data

250m (2 bands), 500-m (7-bands)

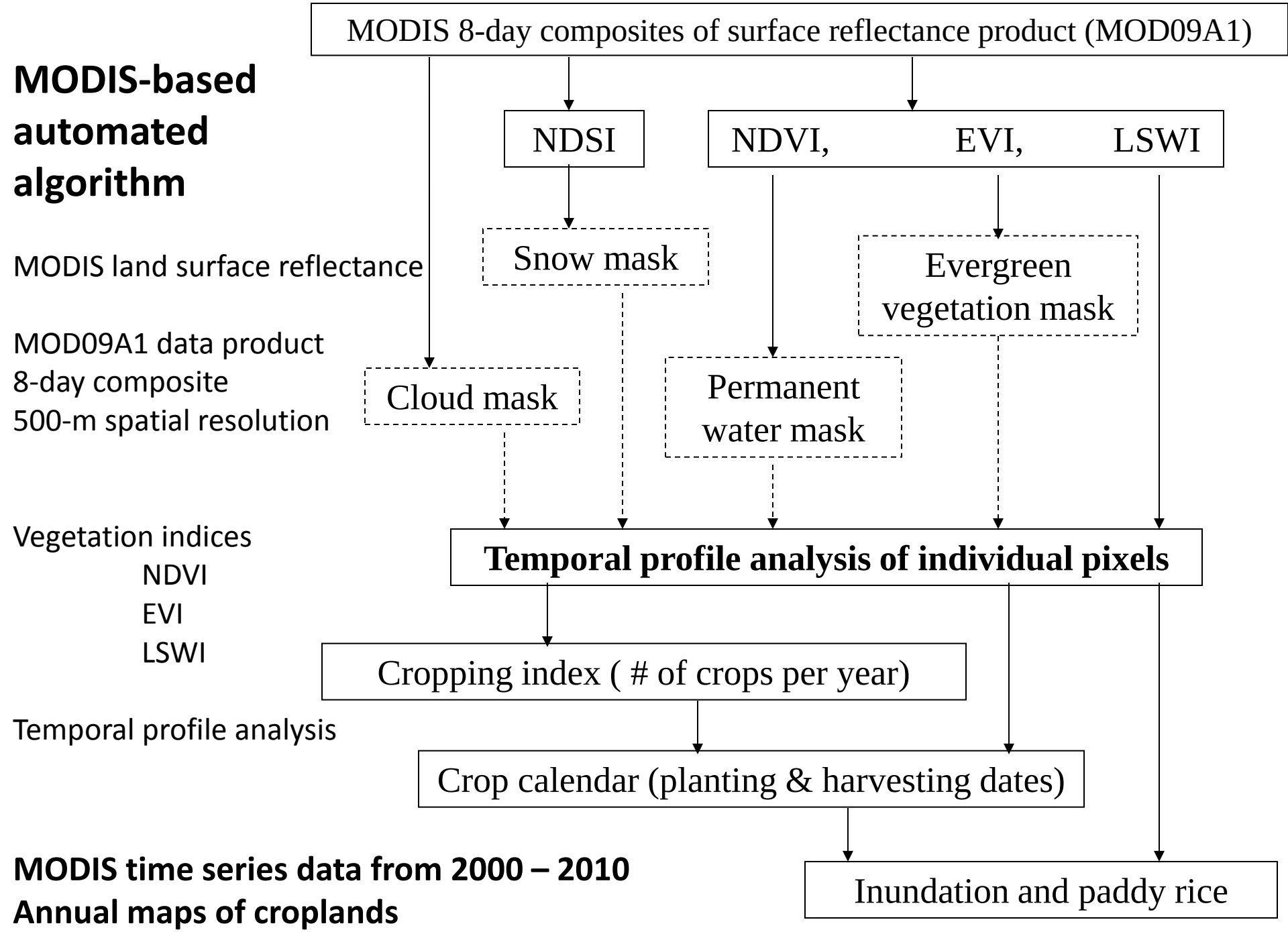
Land surface temperature data

1000-m



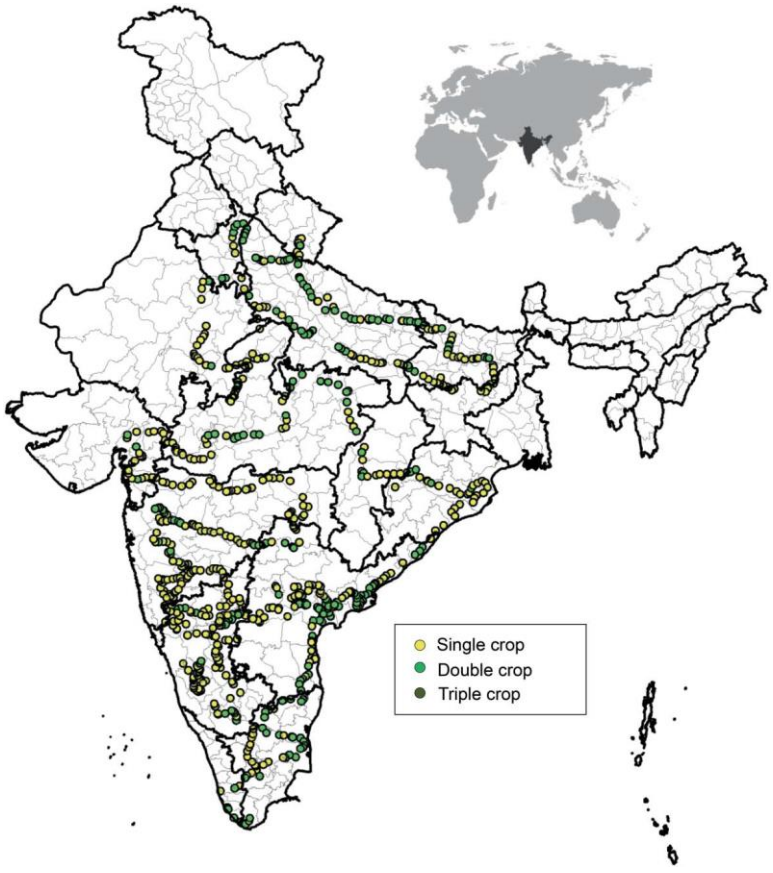


Julian day 145-152 (upper panel) and 185-192 (lower panel) 2000


MODIS-based automated algorithm
MODIS land surface reflectance
MOD09A1 data product
8-day composite
500-m spatial resolution
Vegetation indices
NDVI
EVI
LSWI
Temporal profile analysis
MODIS 8-day composites of surface reflectance product (MOD09A1)
NDSI
NDVI, EVI, LSWI
Snow mask
Evergreen vegetation mask
Cloud mask
Permanent water mask
Temporal profile analysis of individual pixels
Cropping index (# of crops per year)
Crop calendar (planting & harvesting dates)
Inundation and paddy rice
MODIS time series data from 2000 – 2010
Annual maps of croplands

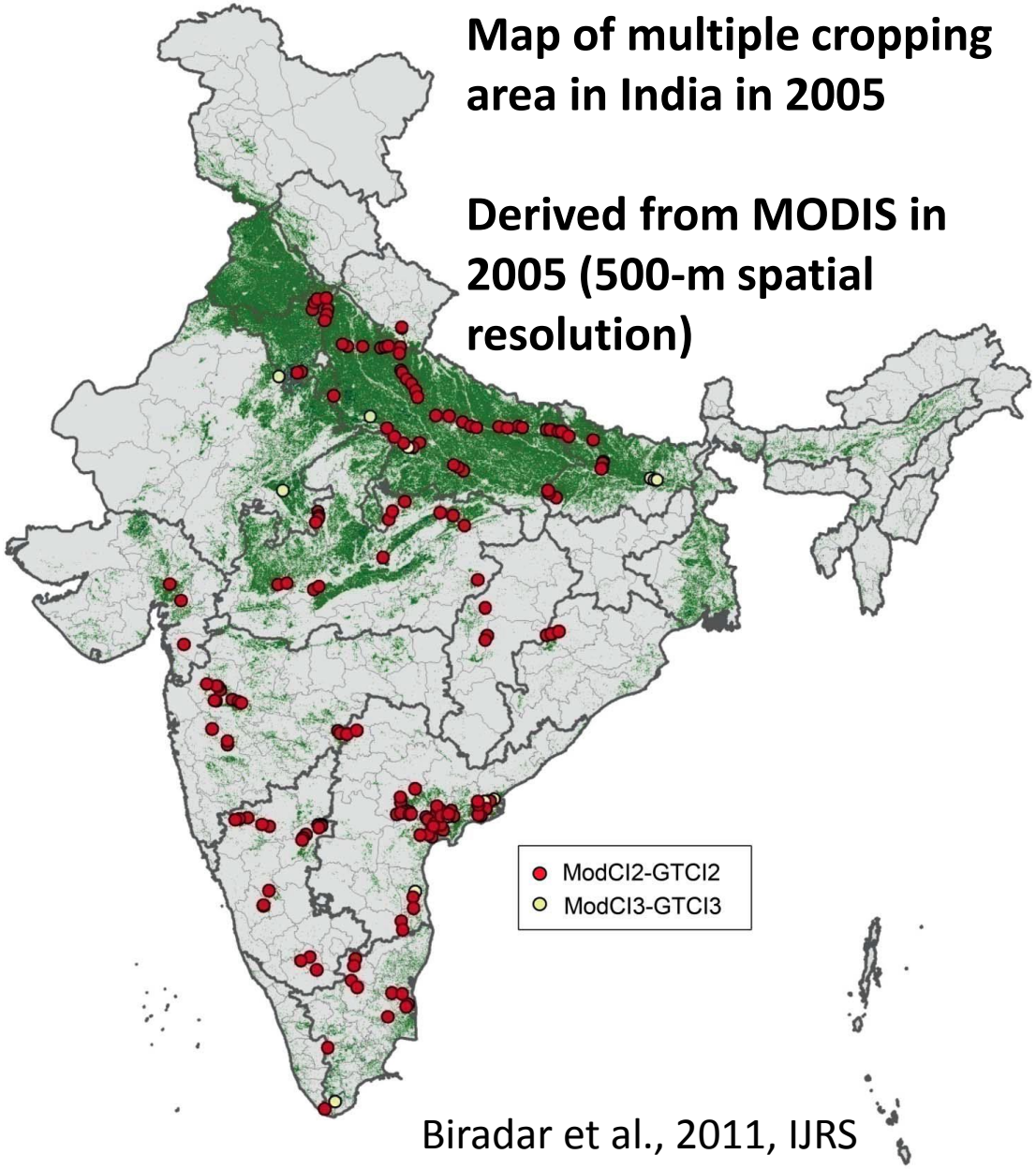
Cropping intensity

Geo-referenced field photos for CAL/VAL



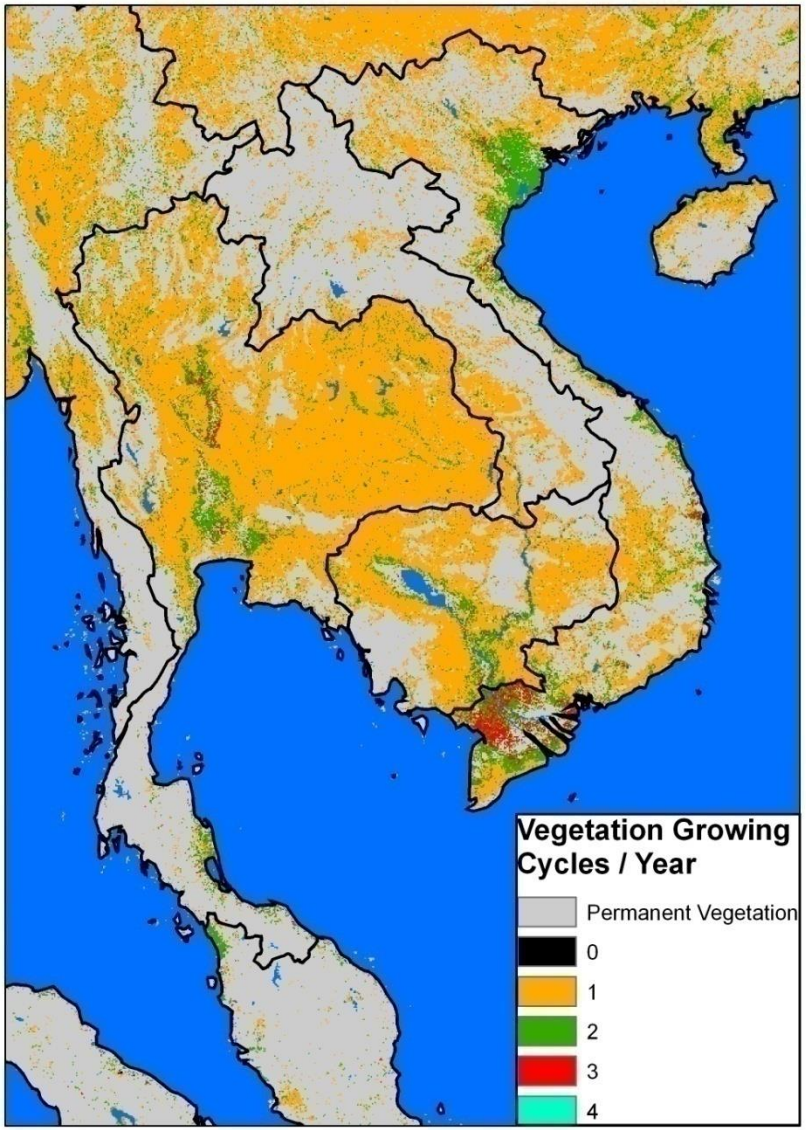
Map of multiple cropping area in India in 2005

Derived from MODIS in 2005 (500-m spatial resolution)

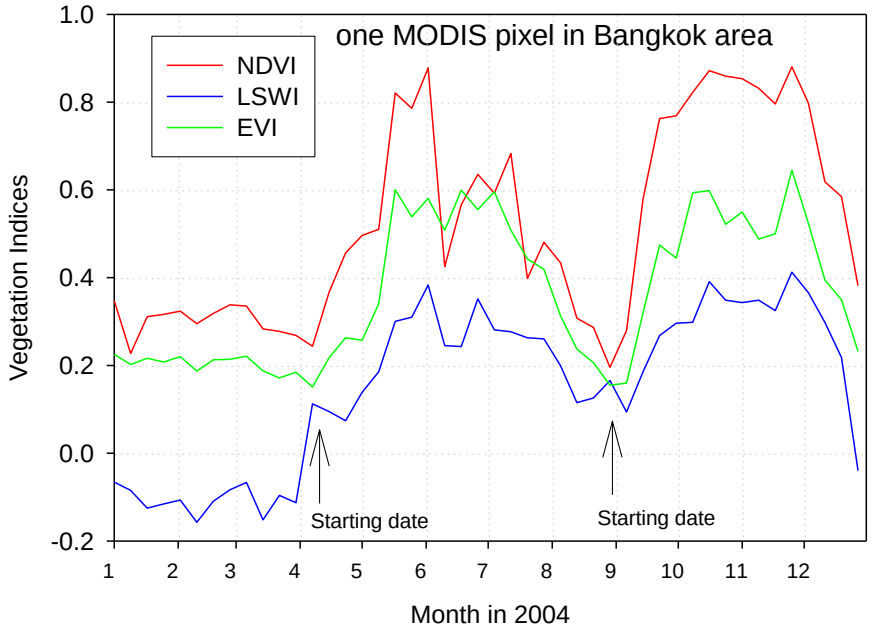


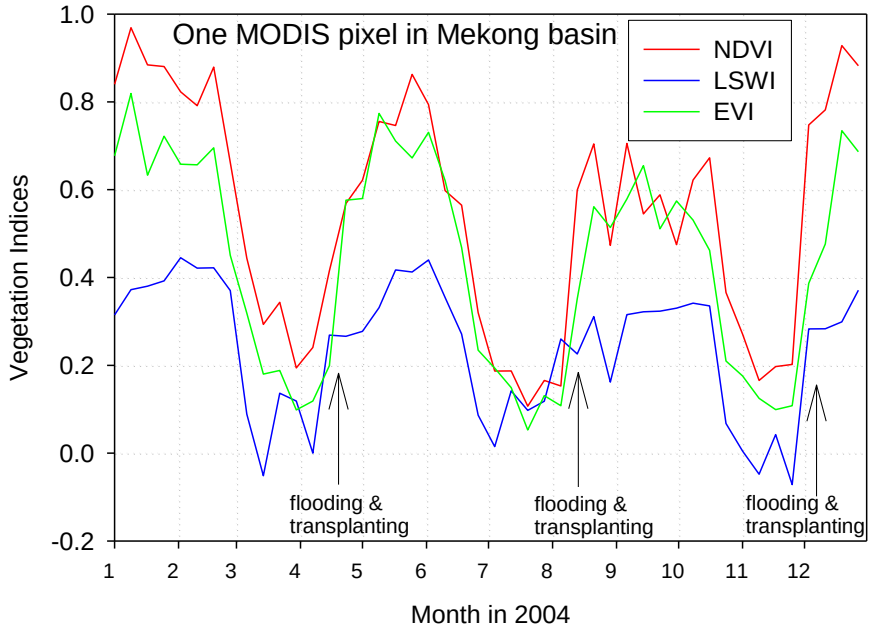
Biradar et al., 2011, IJRS

Maps of croplands from MODIS



Cropping intensity map in 2004





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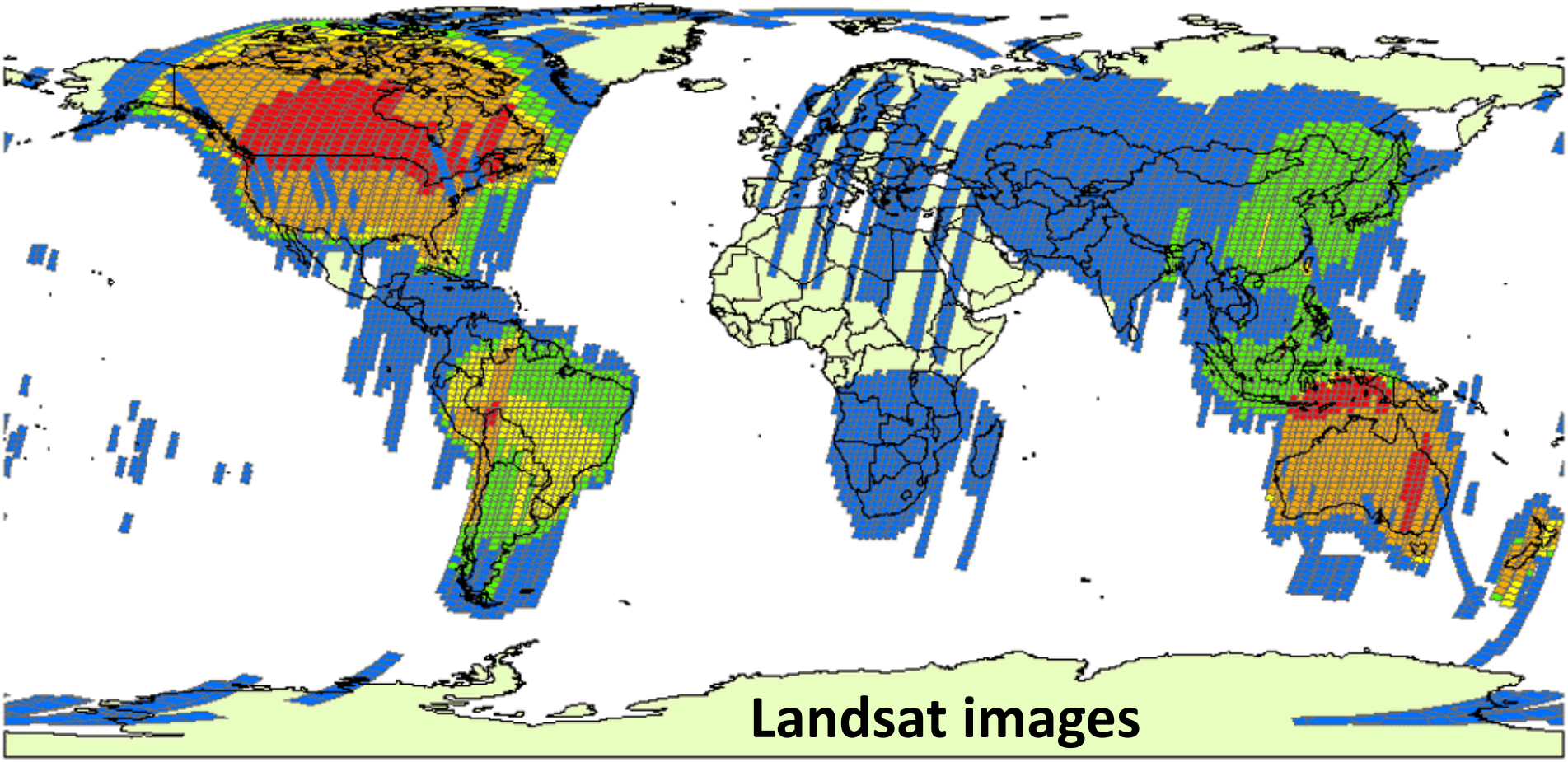
Landsat time series data



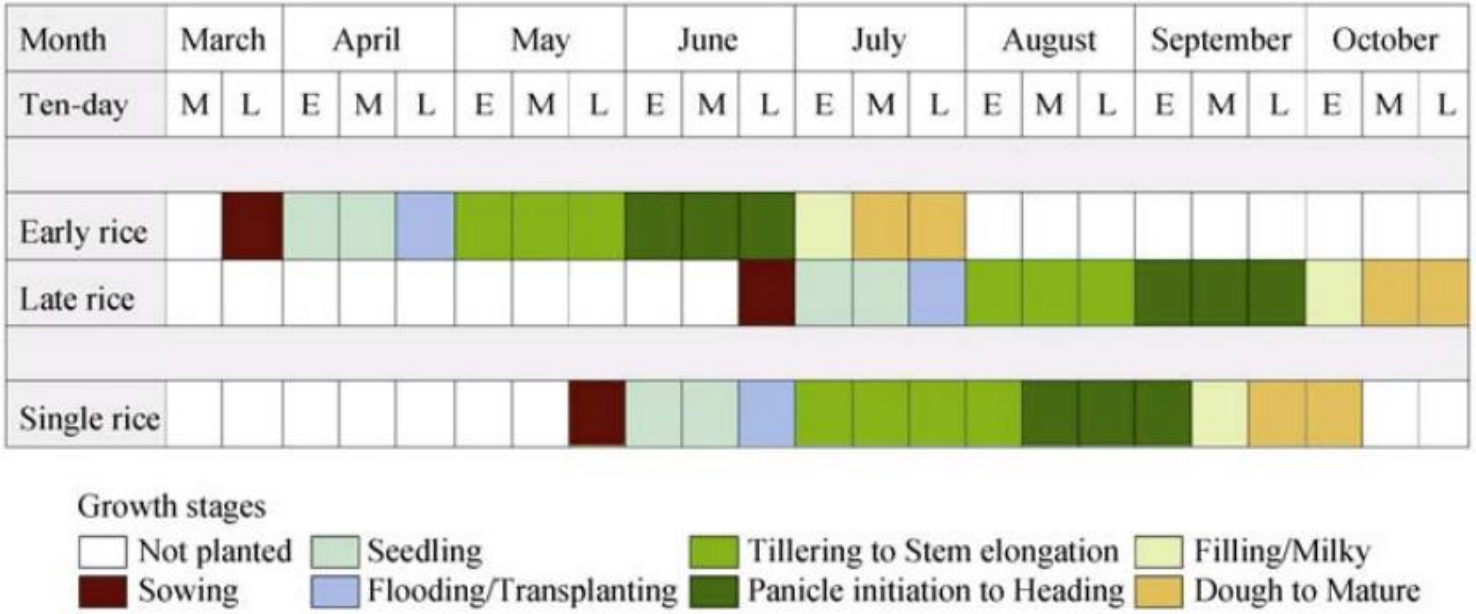
LGAC WRS2 Scenes
Status as of July 31, 2012
Acquisition Date Range: August 22, 1982 through July 30, 2012
1,051,226 Total Scenes Acquired
8,580 Unique Path/Rows

1 - 61 | 62 - 155 | 156 - 258 | 259 - 369 | 370 - 526

Objective: -- Use Landsat time series data to map paddy rice at 30-m spatial resolution

Paddy rice --- multiple Landsat images

Algorithm development

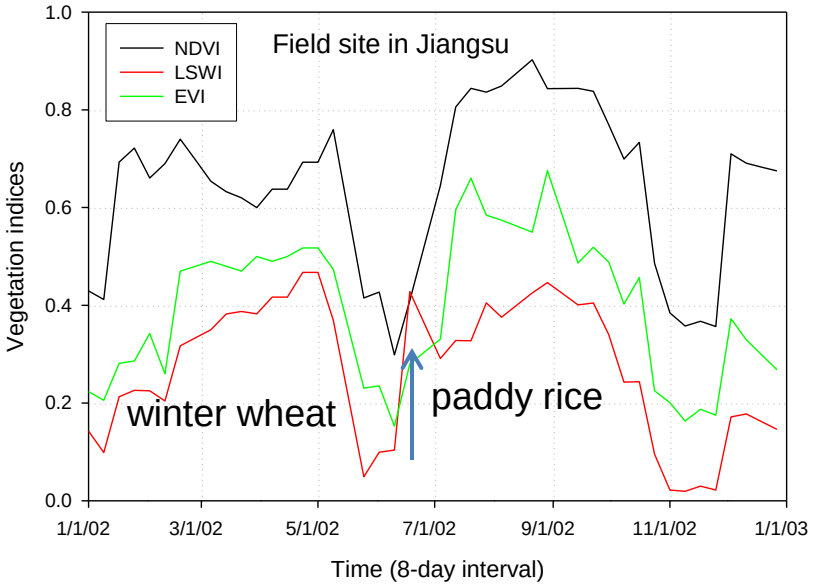


Crop calendar and phenology in Poyang lake, China

Local knowledge from farmers

Paddy rice

Dynamics of winter wheat and paddy rice fields in Nanjing, Jiangsu, China



(c) 7/3/99 2-weeks after rice transplanting

(b) 6/11/99 rice field preparation

(d) 9/6/99 rice plant heading

Paddy rice --- multiple Landsat images

Algorithm development

Transplanting/flooded phase

Canopy closure phase

Will Landsat images acquired in the time windows of these two phases be sufficient to identify and map paddy rice at 30-m spatial resolution?

Paddy rice --- multiple Landsat images

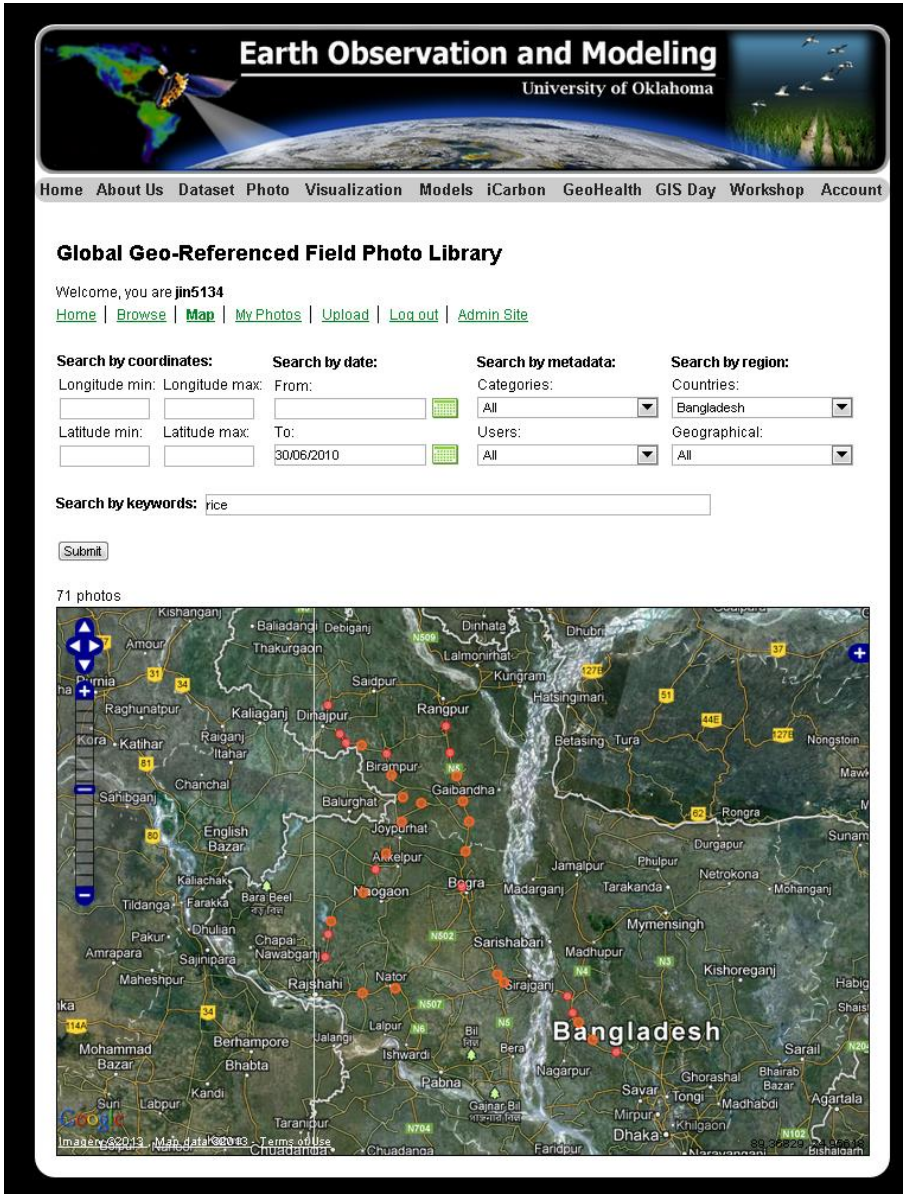
Algorithm development

Case study --- Bangladesh

9 Landsat images during January – April, 2009 – 2010 (p138/r043)

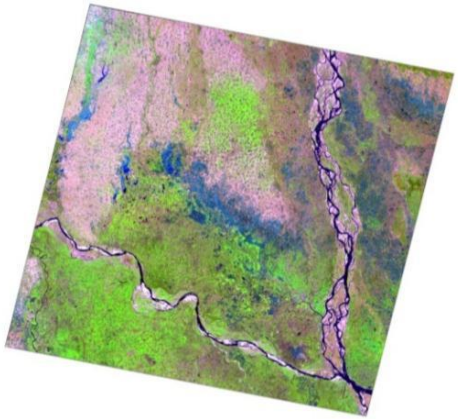
Field surveys were carried out in May 2010. 58 paddy rice ground truth points (with geo-referenced field photos) were collected and located with the Landsat scene.

Fields were flooded in February and paddy rice mature in late April/early May.

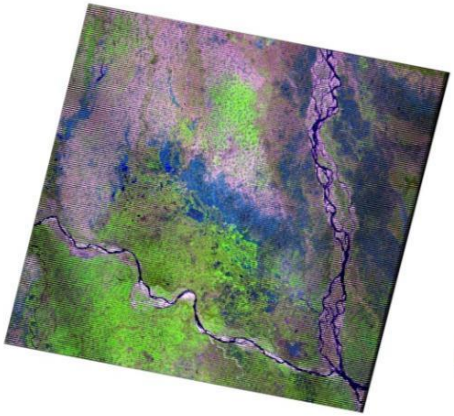


Landsat 5 and 7 images in Bangladesh

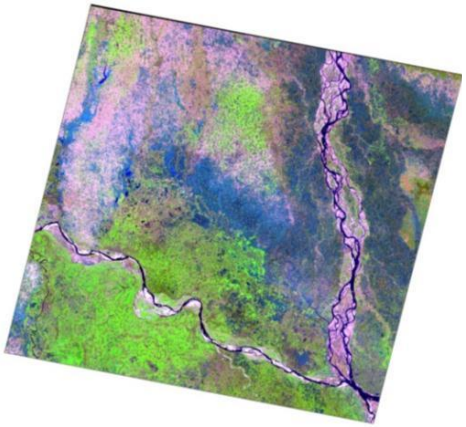
P138r043, RGB=5/4//3



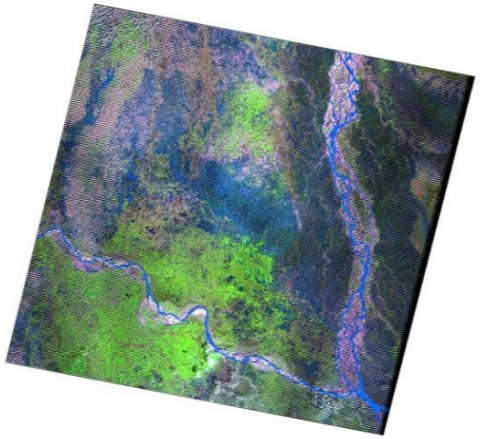
01-21-2010



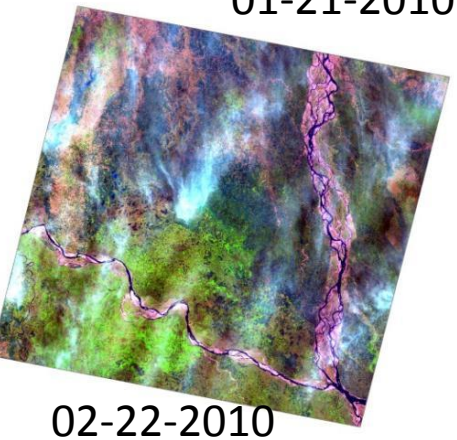
01-29-2010



02-06-2010



02-14-2010



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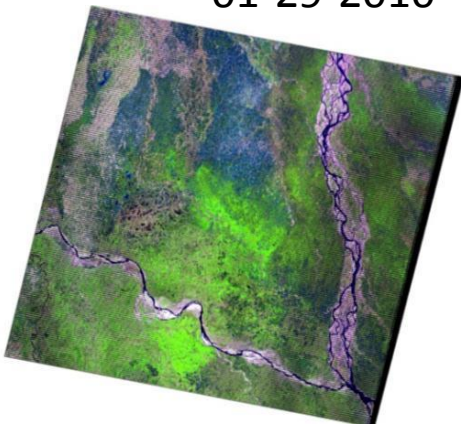
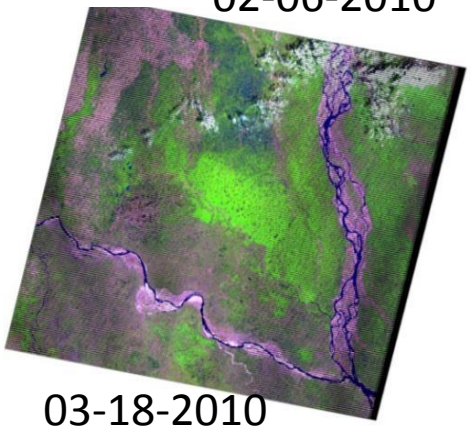


03-02-2010



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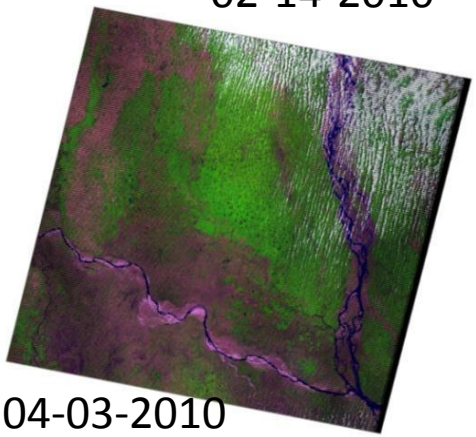
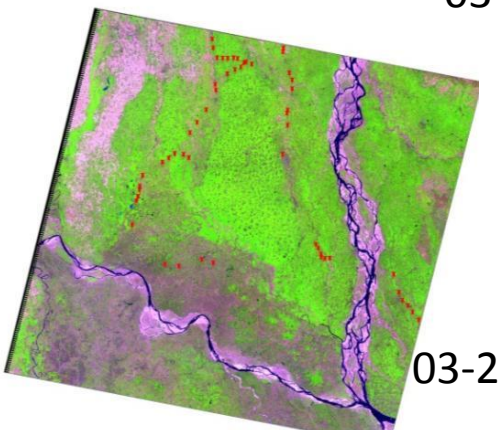


04-03-2010



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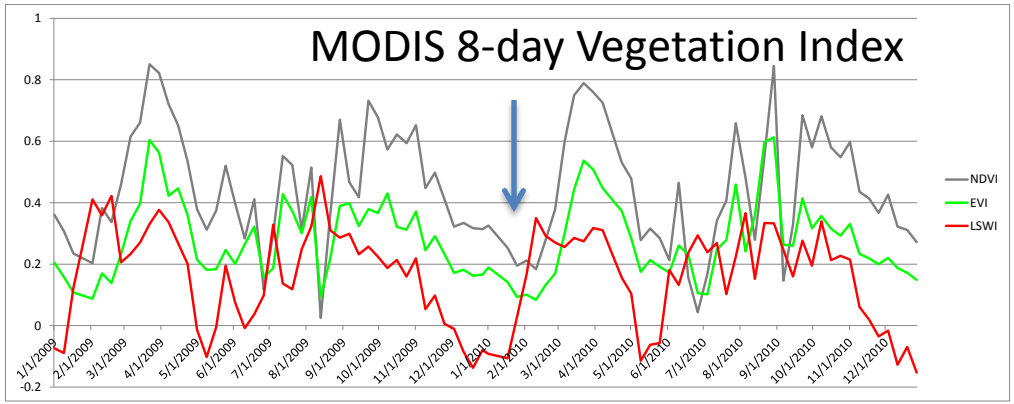
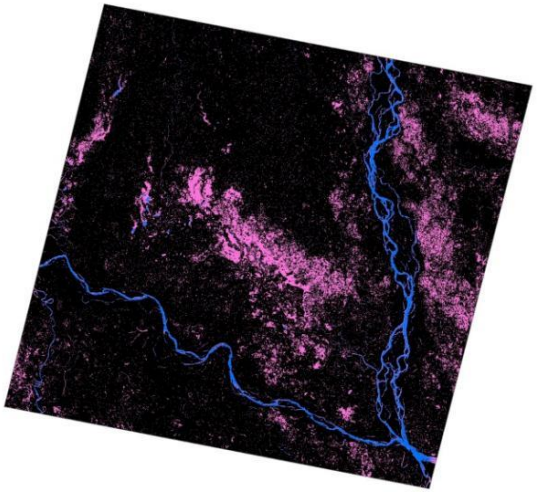
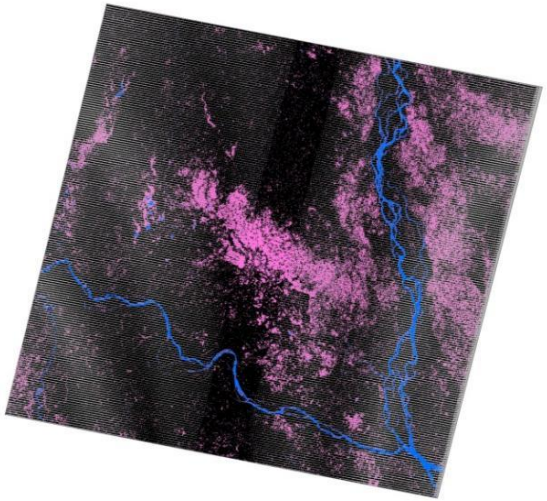


Dynamic maps of transplanting/flooded areas at various dates

Case study --- Bangladesh



01-21-2010



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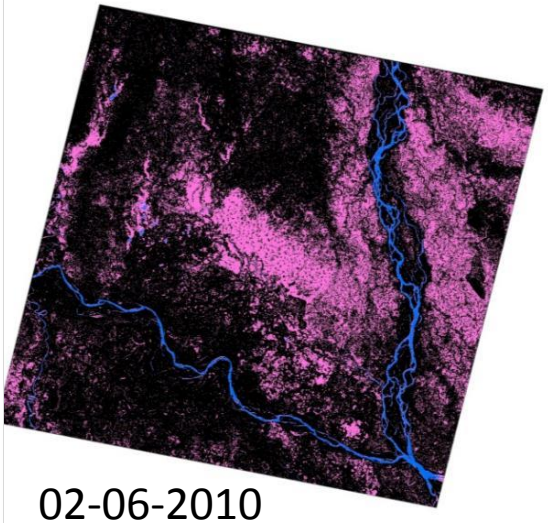
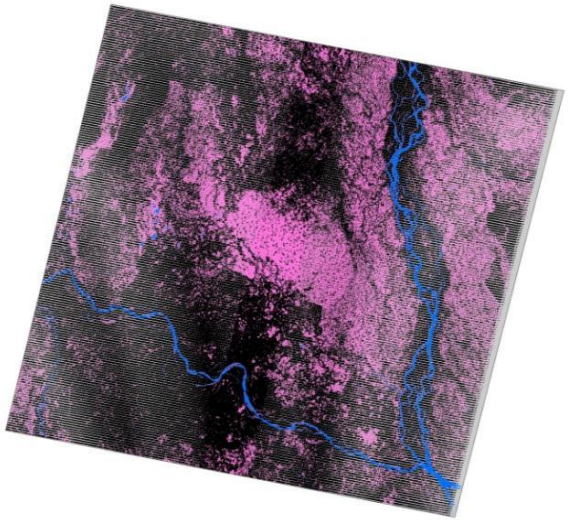


02-06-2010



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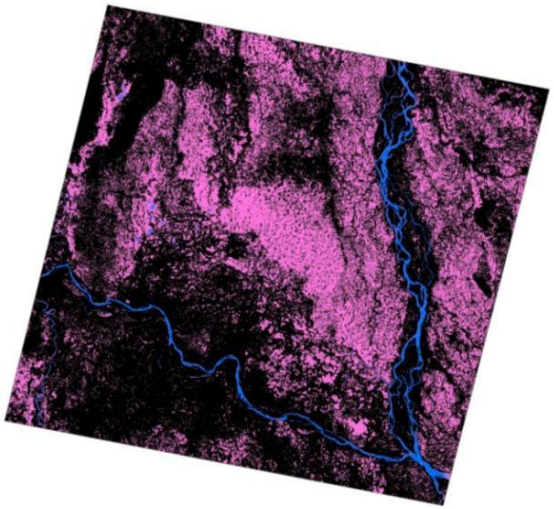

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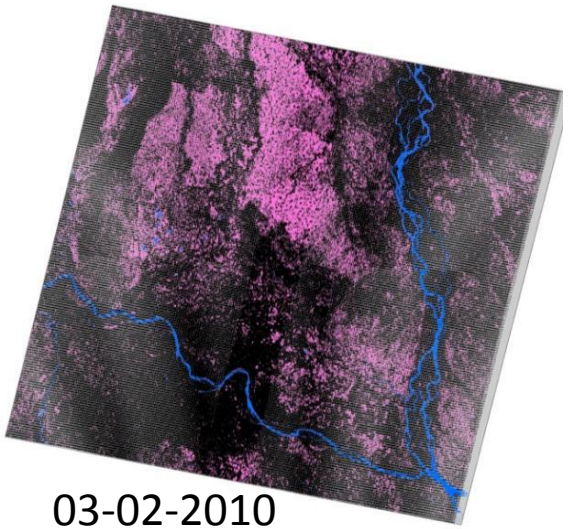
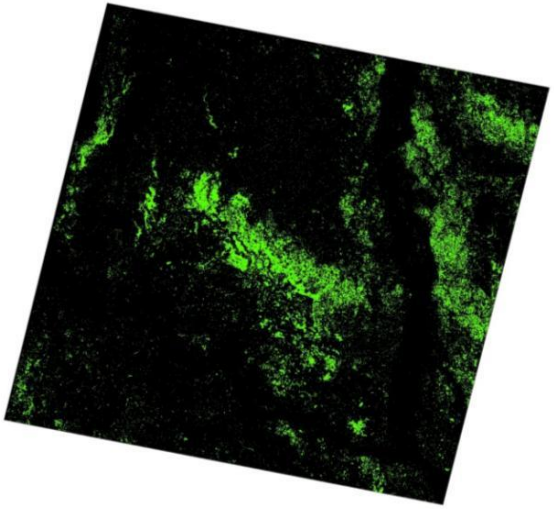


03-02-2010

Flooded WaterBody Non_Flooded Nodata

Dynamic maps of paddy rice fields at various dates

Case study --- Bangladesh



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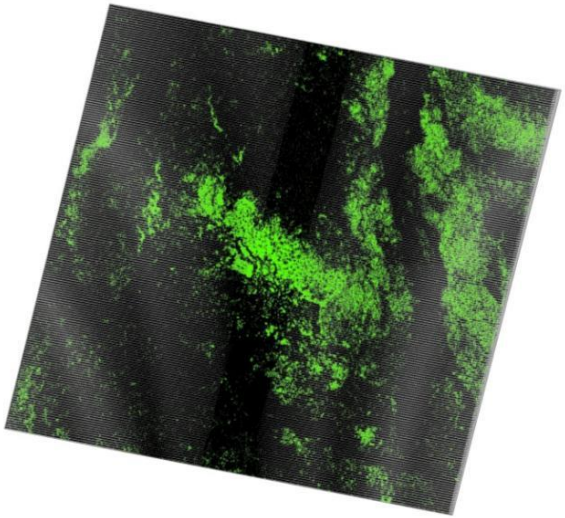
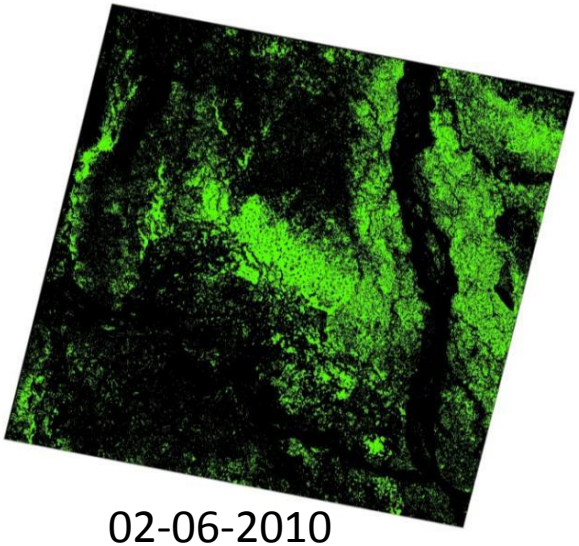


01-29-2010



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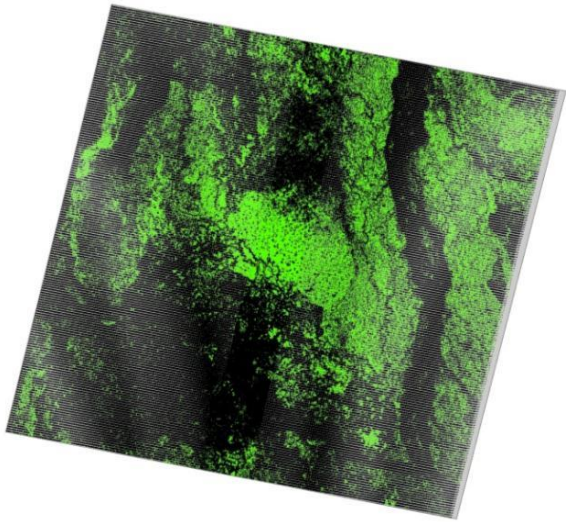

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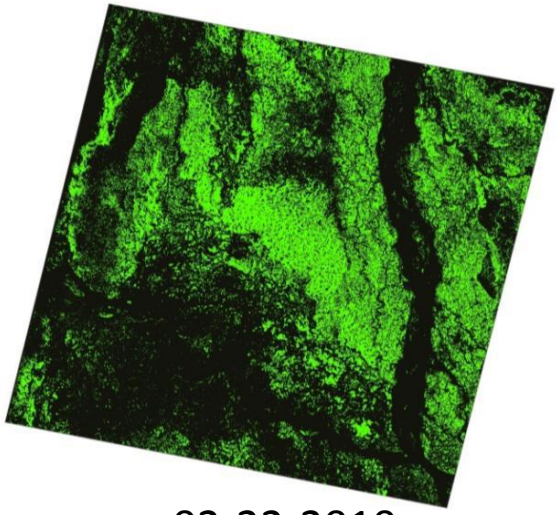

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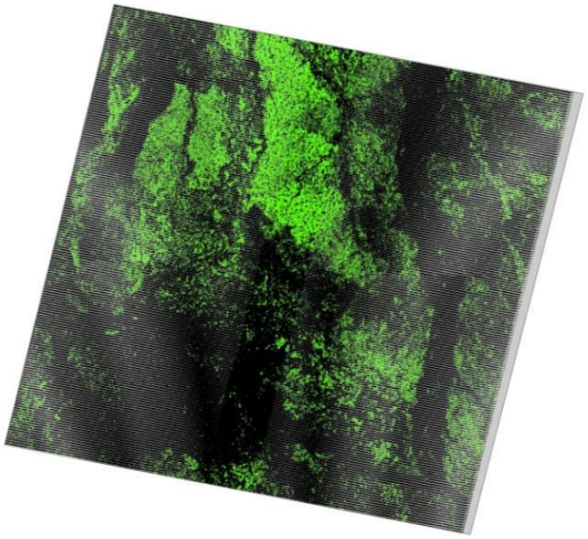
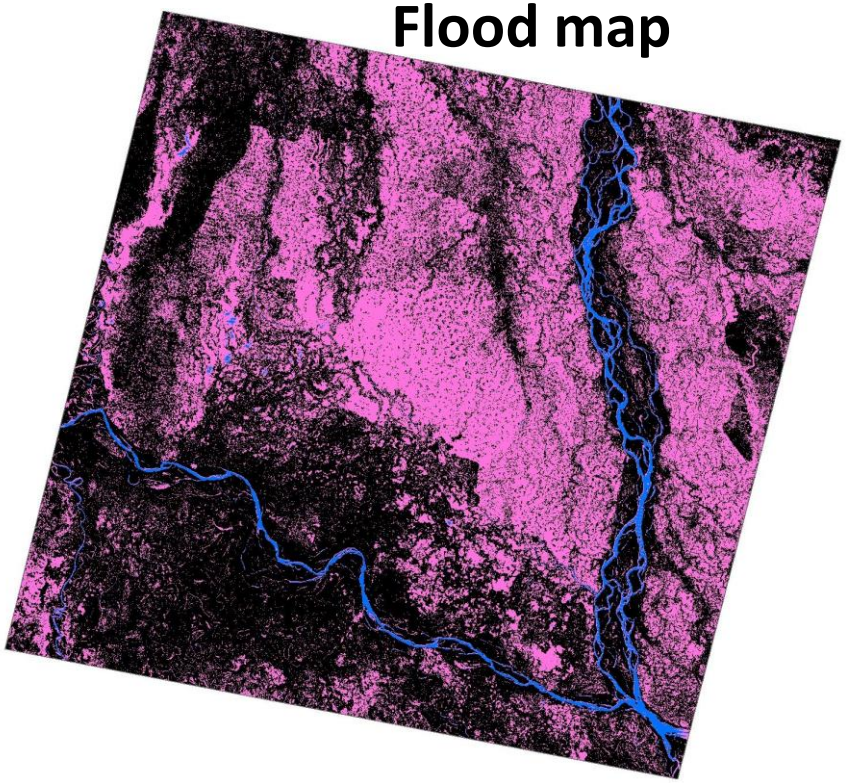


03-02-2010

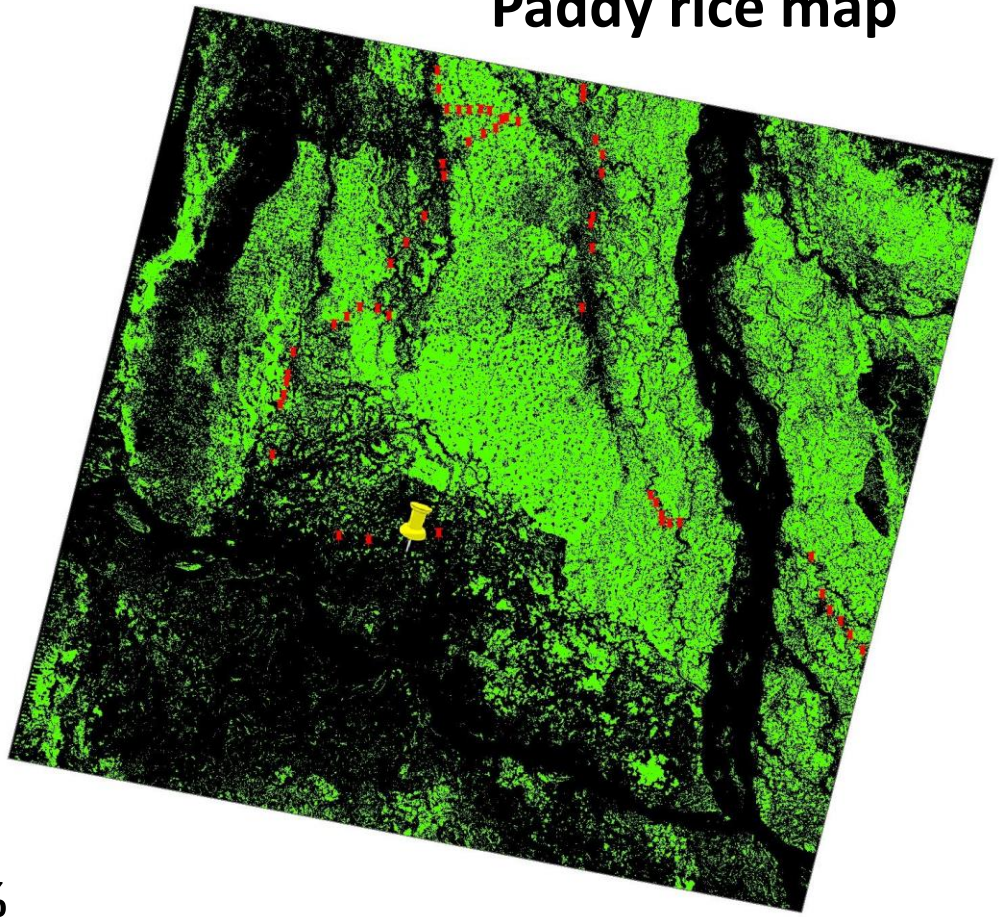
Paddy rice --- multiple Landsat images

Case study --- Bangladesh

Flood map



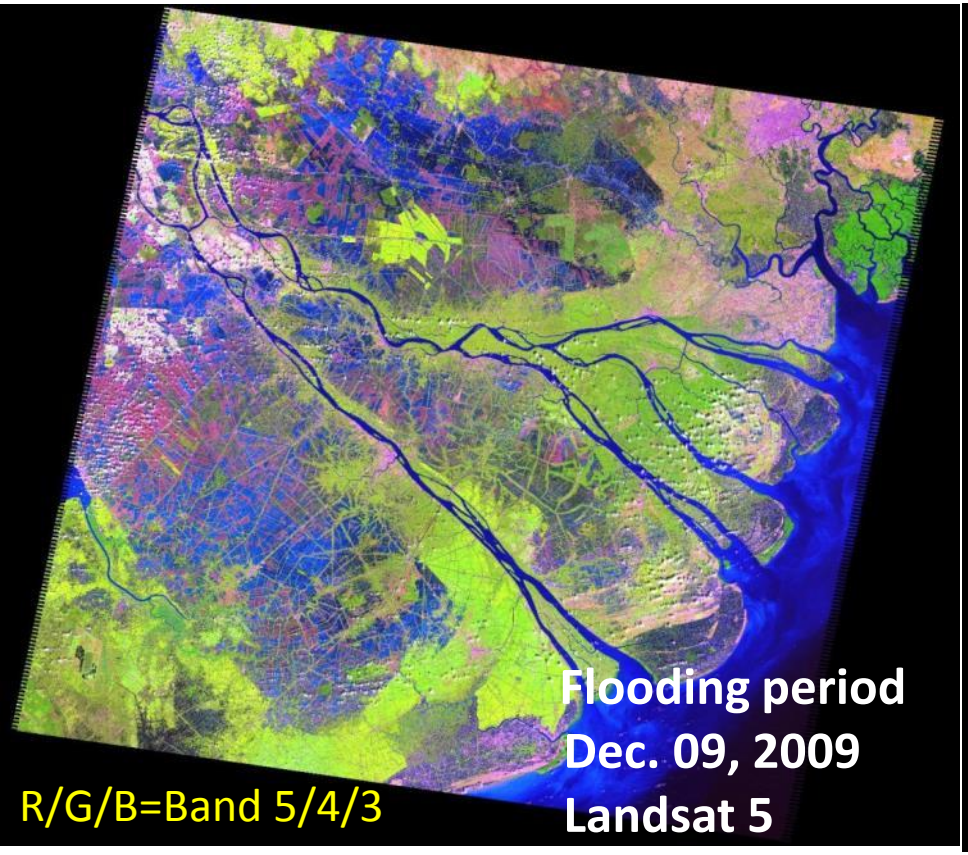
Paddy rice map

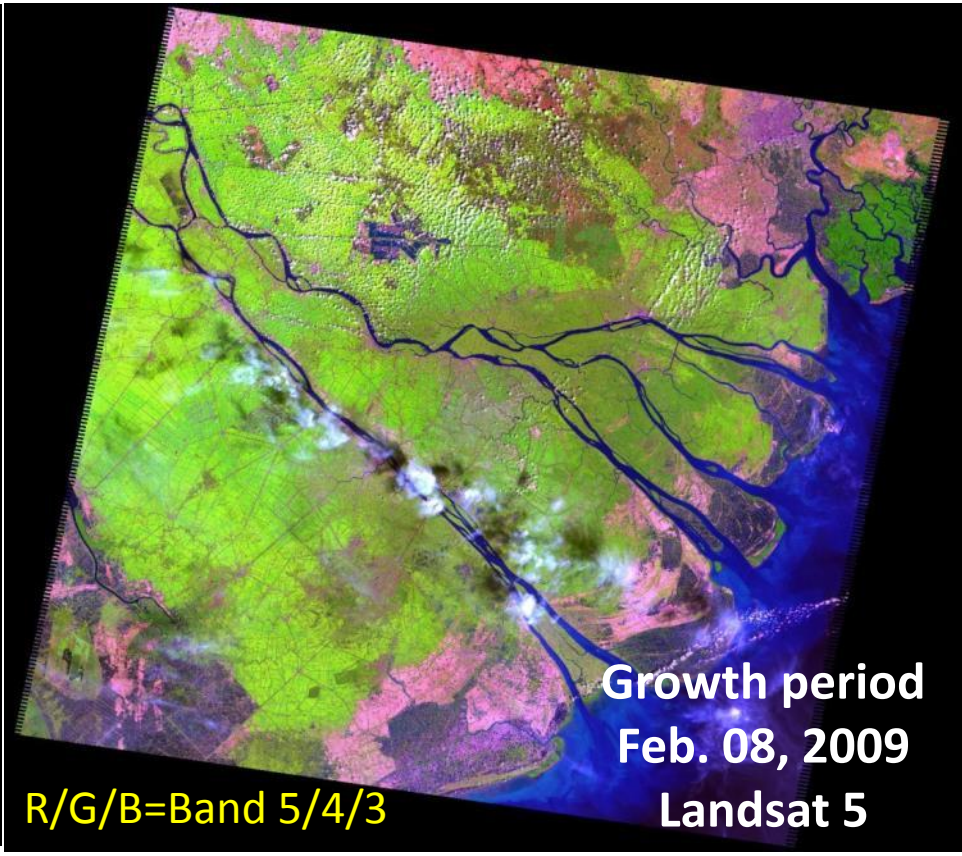


There were 57 ground truth data points, 56 out of 57 points were correctly identified as paddy rice. Accuracy=98.2%

Paddy rice --- multiple Landsat images

Case study – Mekong River Delta in southern Vietnam

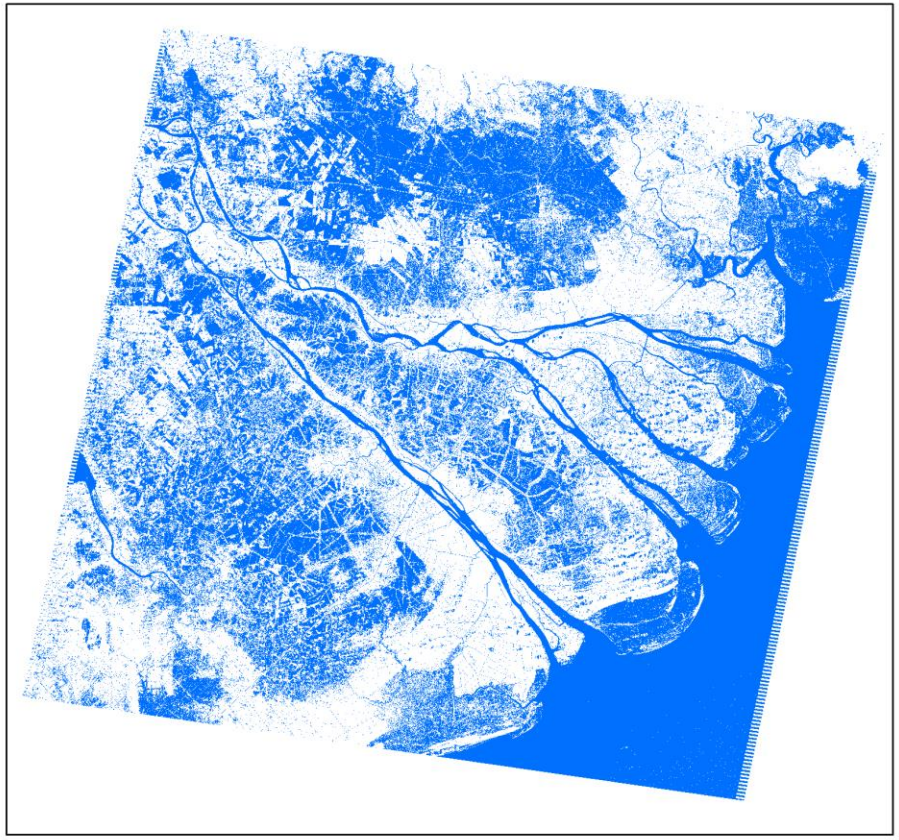




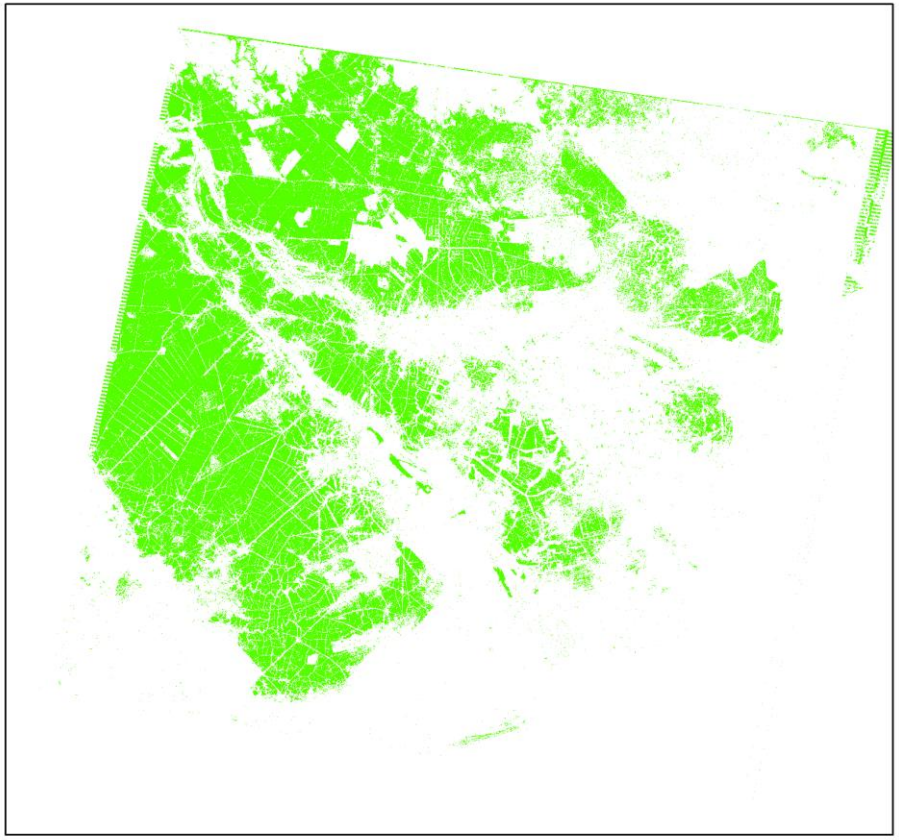
Paddy rice --- multiple Landsat images

Case study –Mekong River Delta in southern Vietnam

Map of transplanting/flooded field



Map of paddy rice field



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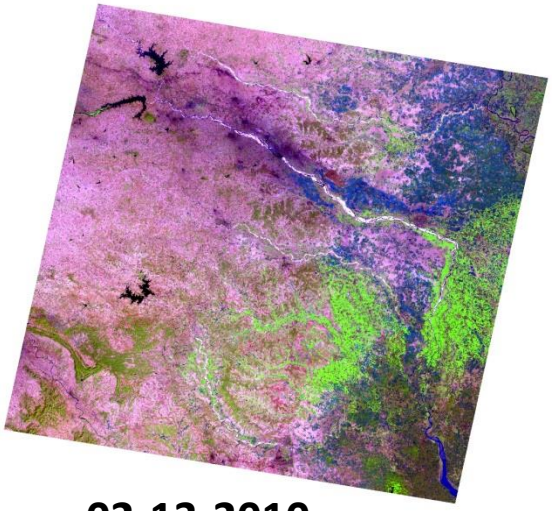
Paddy rice --- multiple Landsat images

Case study -- India

Landsat 5 p139r044



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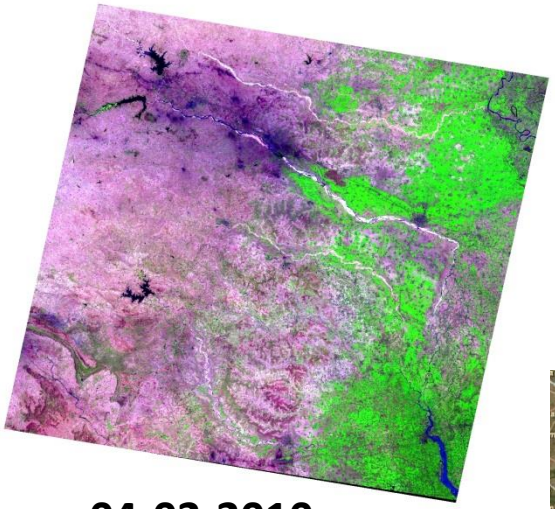
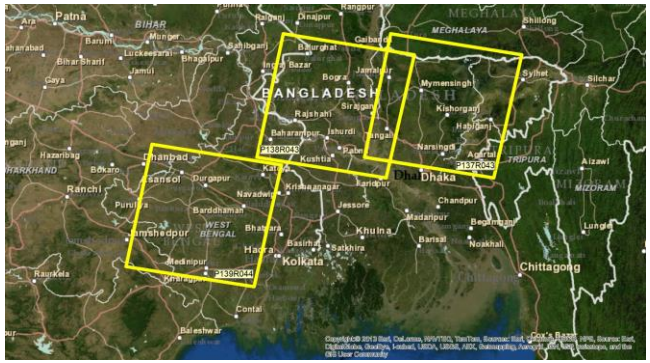
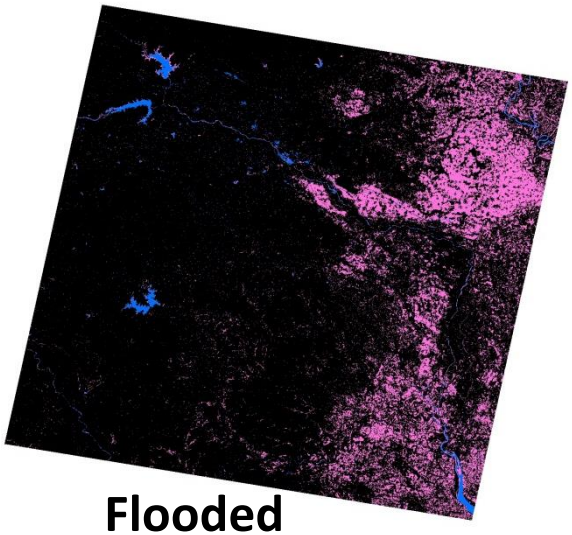
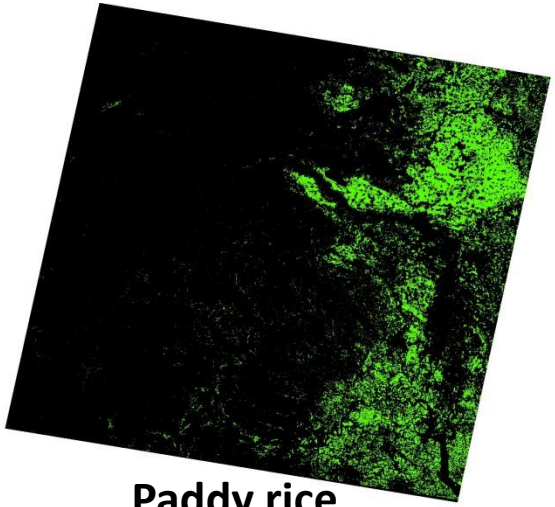


04-02-2010





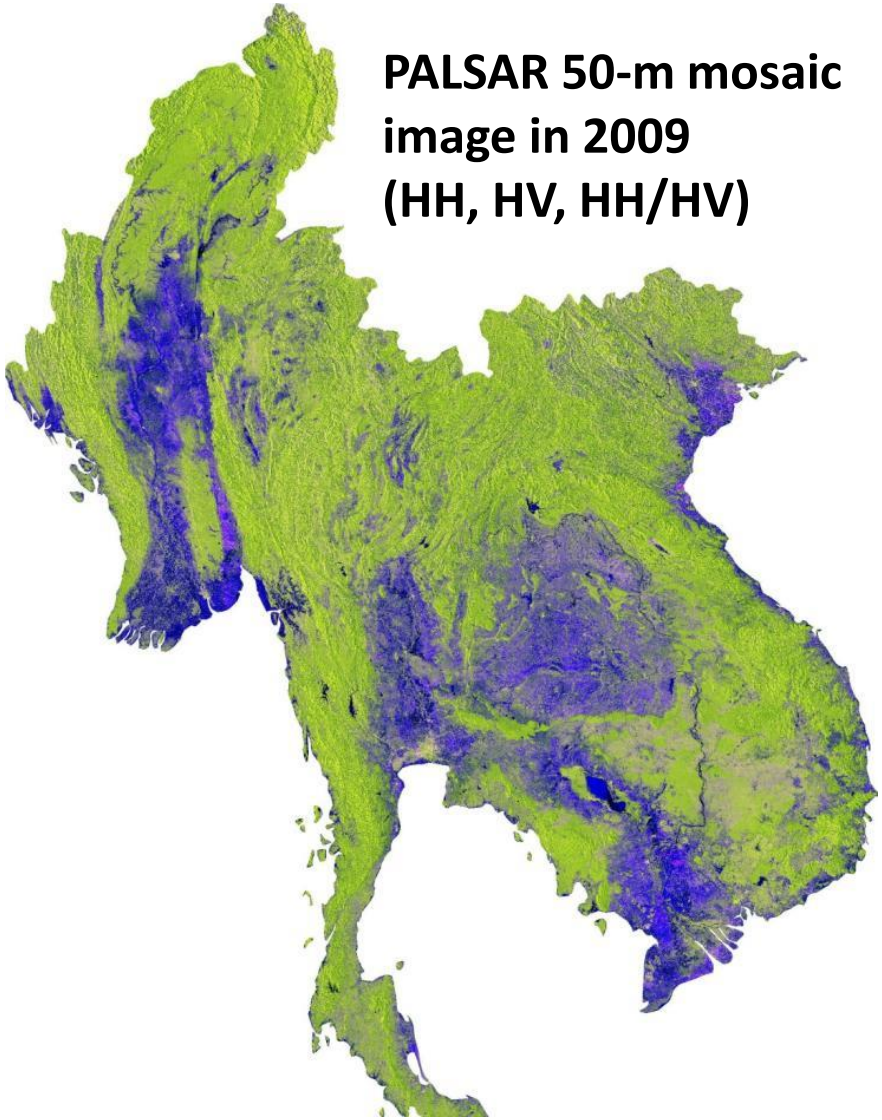
Flooded



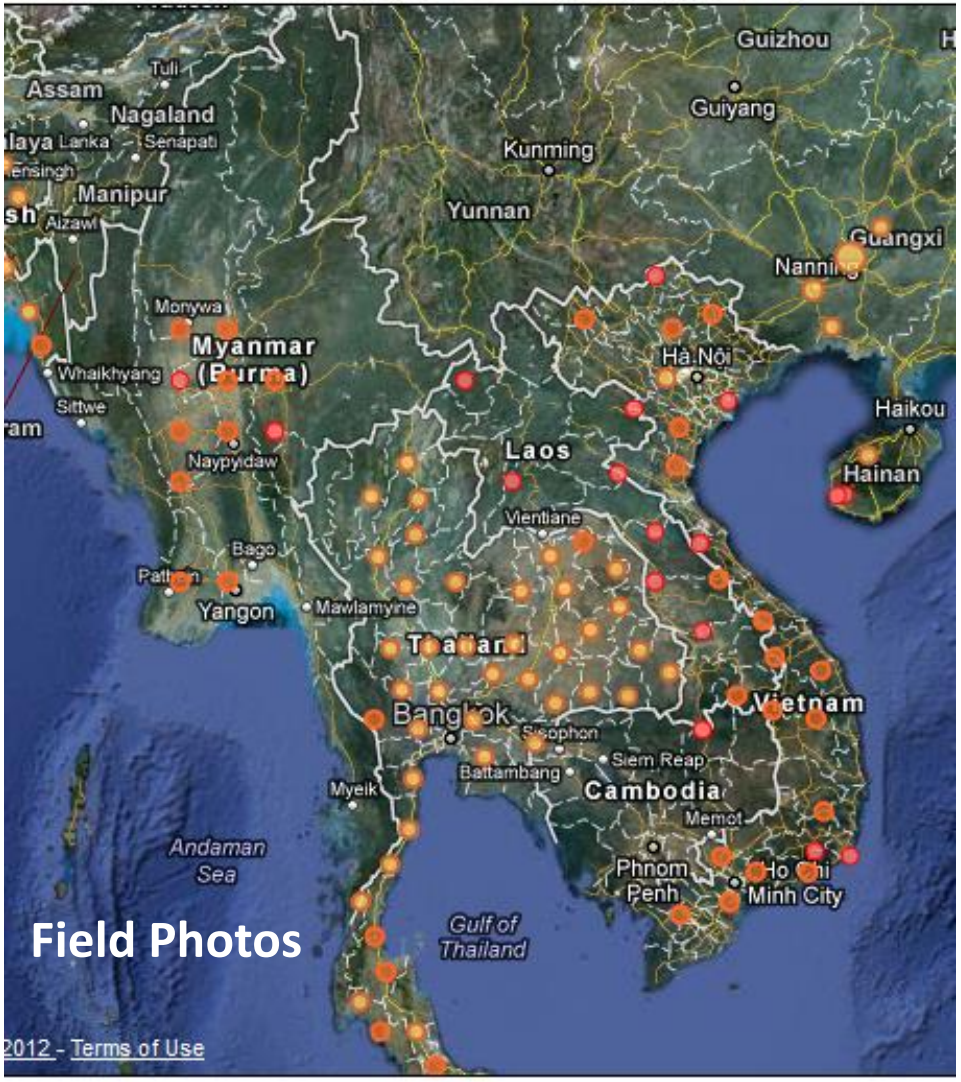
Paddy rice

PALSAR-based mapping of land cover

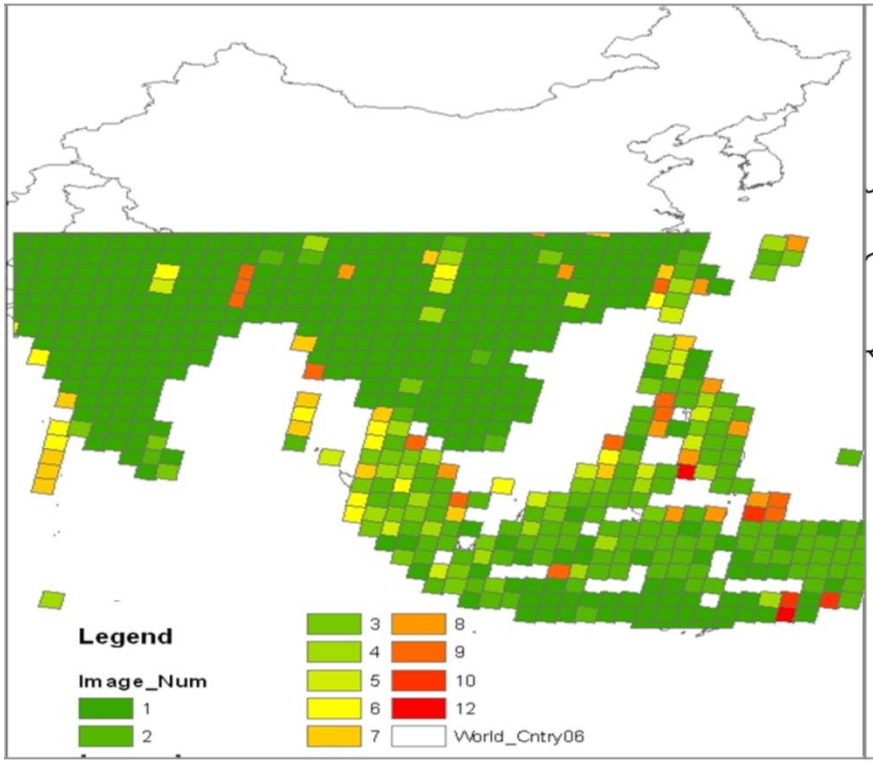
Mapping land cover in Southeast Asia at 50-m resolution



PALSAR 50-m mosaic image in 2009 (HH, HV, HH/HV)

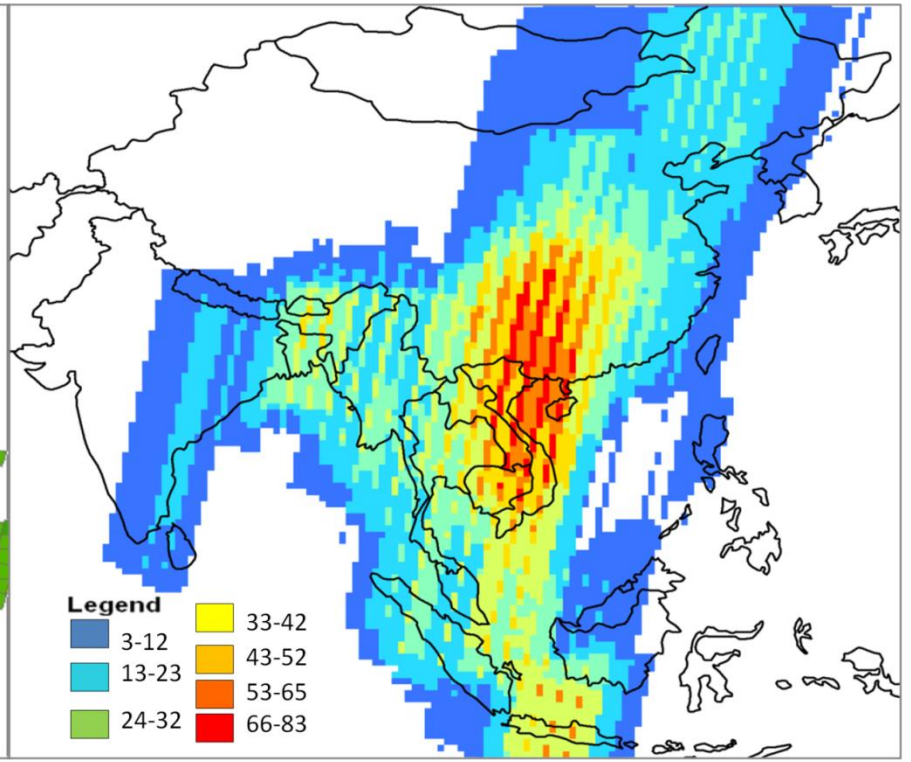


GLS-2005 Landsat



South East Asia GLS2005 Landsat TM/ETM+

PALSAR ScanSAR imagery



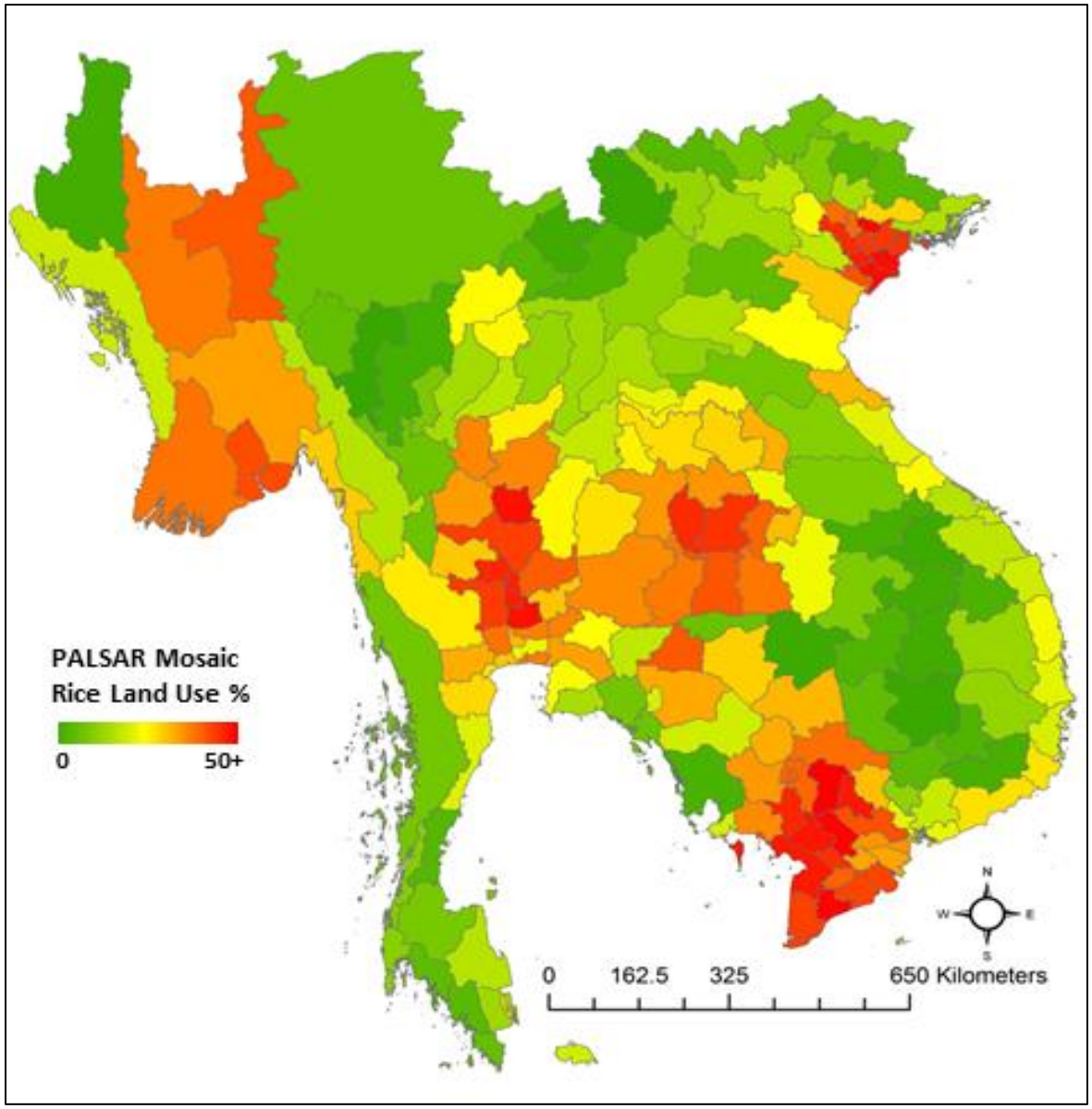
South East Asia K&C ScanSAR strips 2007-2009 ORT/SLT

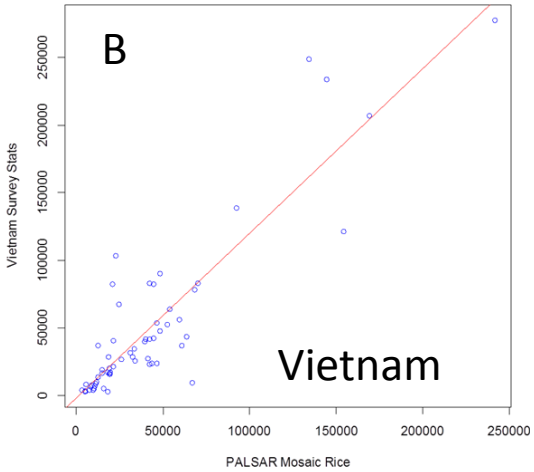
PALSAR HH images

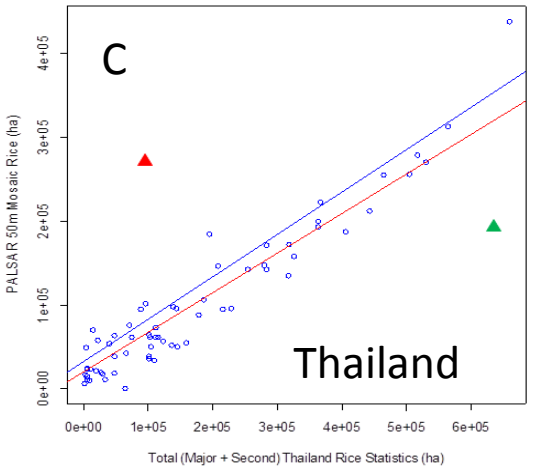
R: 9/21/2011
G: 2/3/2011
B: 11/6/2011

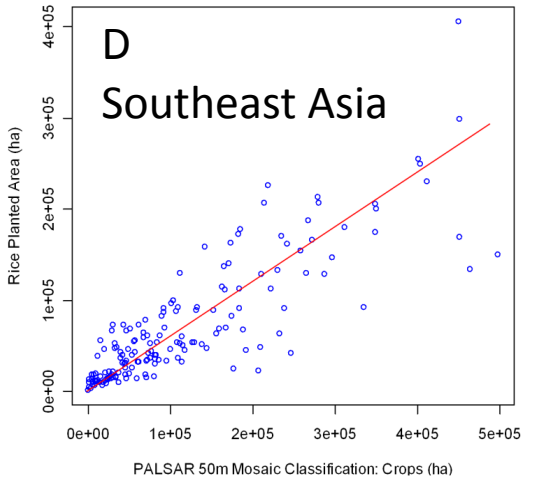
PALSAR-based map of paddy rice in 2009 at 50-m spatial resolution

A









Summary and Future Work

- **Completed MODIS-based algorithms and map cropping intensity, crop calendar, inundation and paddy rice in tropical monsoon Asia from 2000 - 2010**
- **Evaluated PALSAR-based algorithms and map cropping intensity, inundation, paddy rice and forests in southeast Asia in 2009/2010**
- **Now evaluate Landsat-based algorithms for mapping inundation and paddy rice in tropical monsoon Asia**

Publications relevant to the project

Biradar et al., 2011, IJRS; Dong et al., 2012, JPRS; Dong et al., 2012, RSE; Dong et al., 2013, RSE (in press); Dong et al., 2013, RSE (in revision); Fuller et al., 2013, EID; Jin et al., 2013, RSE (in press) ; Xiao et al., 2011, AGU EOS; Zhang et al., 2013, PNAS

Future work

1. **Write papers for the Landsat/PALSAR/MODIS algorithms, decadal changes in cropping intensity and paddy rice.**
2. **Streamline the algorithms and procedure and then implement them in NASA NEX computing facility , where global Landsat images are available.**

To generate two data products at 30-m spatial resolution in tropical monsoon Asia

1. **Maps of transplanting/flooded croplands**
2. **Maps of paddy rice field**


Questions?