

# Monitoring of rice crops in the Mekong Delta, Vietnam using multi-temporal Sentinel-1 data

Nguyen Lam-Dao, Phung Hoang-Phi

Ho Chi Minh City Space Technology Application Center (STAC)–VNESC–VAST

Thuy Le-Toan

Centre d'Etudes Spatiales de la BIOSphère (CESBIO), France

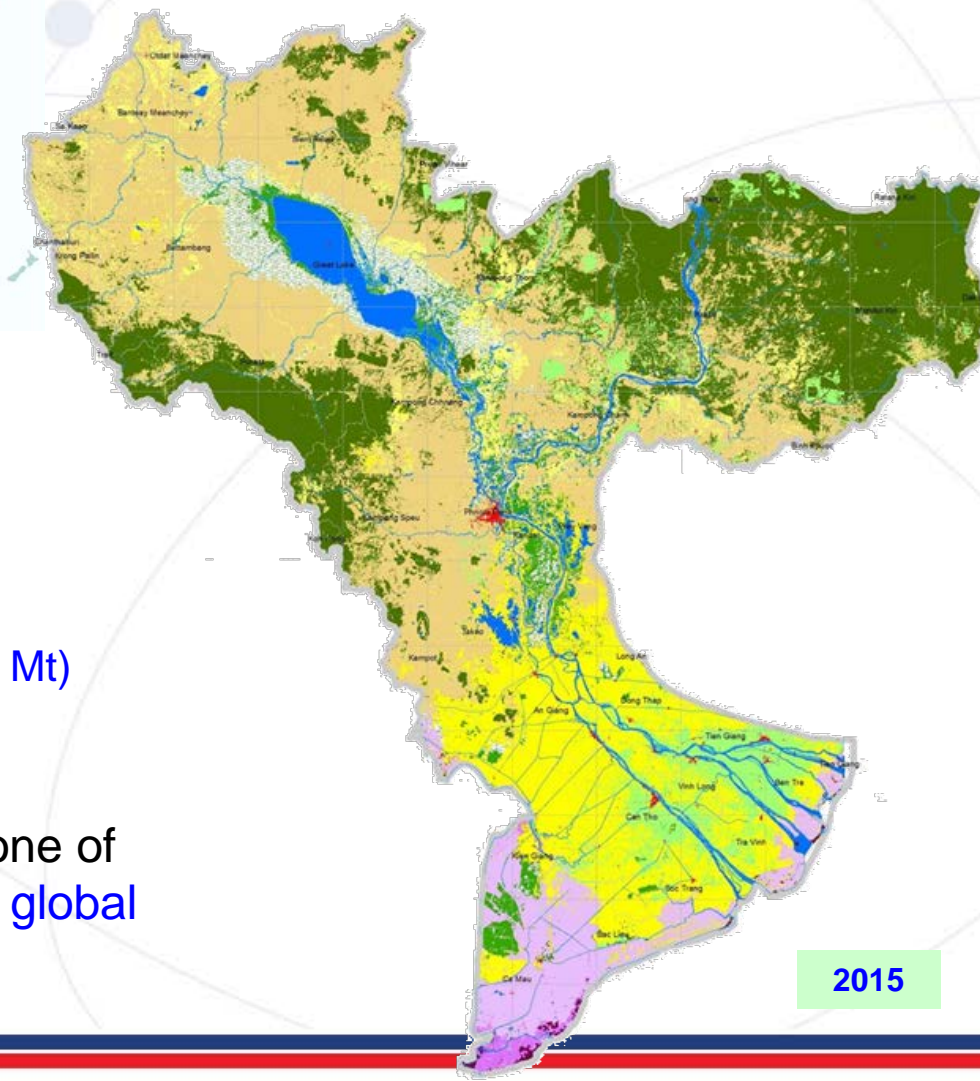
Mai Thy Pham-Thi

GIS and Remote Sensing Research Center (GIRS)–HCMIRG–VAST

1. Introduction
2. Previous research results
3. Ongoing research works
4. Discussion



Source: Parry, M.L. et al., 2007



## Mekong Delta (Source: GSO, 2015):

- Area: 40,576 Km<sup>2</sup> (1/8)
- Population: 17.590 M (~1/5)
- MD accounts for more than half (25.7 / 45.2 Mt) of the country's rice production (>1/2)

The Mekong Delta, South of Vietnam is one of the most affected regions in the world by global warming.

Rice cropping system	Rice season
Single rice crop	Traditional rice (rain-fed)
Double rice crop	SA – AW (rain-fed)
	WS – SA (irrigated)
Triple rice crop	WS – SA - AW



Sowing-transplanting period



Vegetative stage



Reproductive stage



Ripening stage

Pictures of rice growing stages

Main rice-based cropping systems in the MD

Rice crop		Planting	Harvesting
English name	Local name		
Winter Spring ( <b>WS</b> )	Dong Xuan	Nov./Dec.	Mar./Apr.
Summer Autumn ( <b>SA</b> )	He Thu	Apr./May	Jul./Aug.
Rainy season	Thu Dong (Autumn Winter- <b>AW</b> )	Jul./Sep.	Oct./Dec.
	Mua (Traditional rice)	Jul./Sep.	Nov./Jan.

Main rice seasons in An Giang province, Mekong Delta

## Previous projects

### 1. Rice & Mangrove monitoring in Southern Vietnam - RICEMAN

- TerraSAR-X & ENVISAT-ASAR data, **2010-2011**
- Rice mapping: [Single-date mapping algorithm](#)
- Yield estimation model: [Statistical model](#).

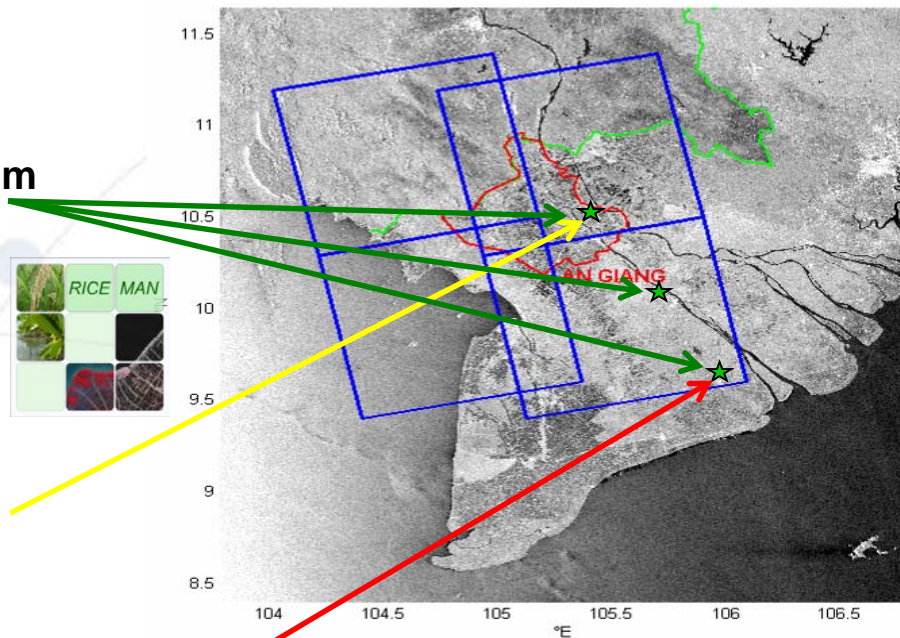
### 2. Rice crop monitoring using new generation synthetic aperture radar (SAR) imagery

- **ENVISAT-ASAR data, 2007-2008**
- Rice mapping: [Single-date mapping algorithm](#)
- Yield estimation model: [Statistical model](#).

### 3. Utilisation of SAR data for rice crop monitoring

- **ERS2-SAR data, 1997-1998**
- Rice mapping: [Temporal change measurement](#)
- Yield estimation model: [Agro-meteorological model \(AMM\)](#).

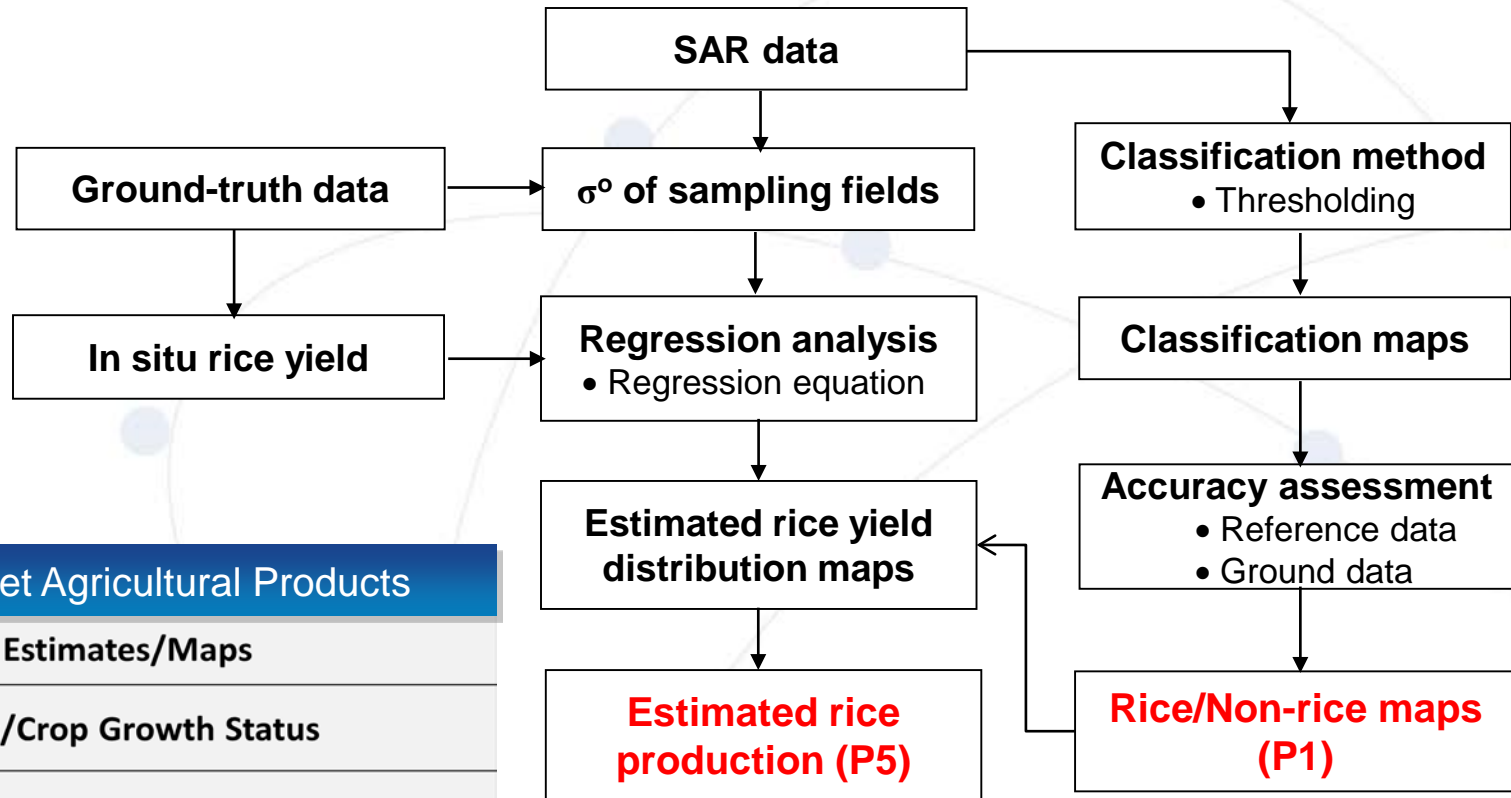
### 4. Other projects in the Mekong and Red River Delta



## Ongoing projects

1. **SAFE/APRSAF (2013-2017) & Asia-RiCE**
2. **GeoRice (2015-2017)**

- Data used: COSMO-SkyMed, RADARSAT-2, ALOS-2, Sentinel-1.



## Asia-RiCE Target Agricultural Products

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

## SAR data received:

COSMO-SkyMed: Aug 2013 – Feb 2014

RADARSAT-2: Aug 2013 – Now

Sentinel-1: Aug 2014 – Now

ALOS-2: Nov 2014 – Now

### COSMO-SkyMed data:

- Band: X
- Polarisation: HH&VV
- Resolution: 20 m (StripMap PINGPONG)

### RADARSAT-2 data:

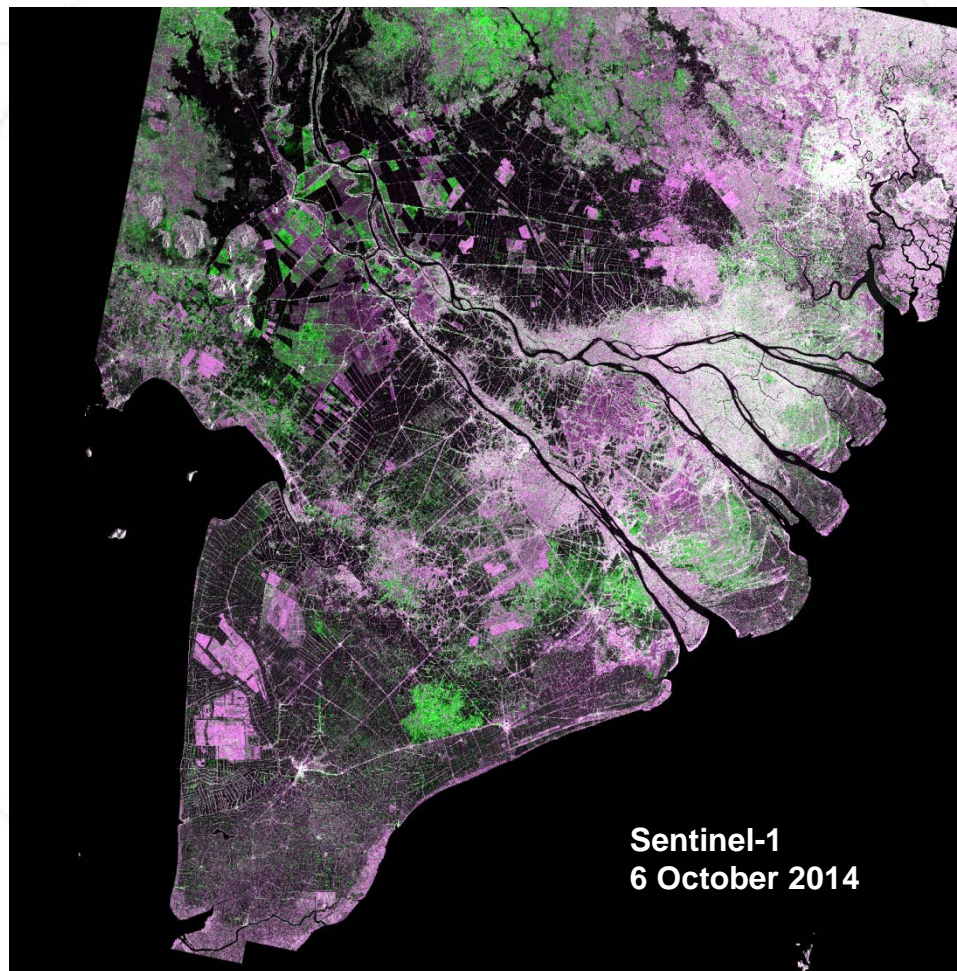
- Band: C
- Polarisation: VV&VH
- Resolution: 10 m (Wide Fine)

### Sentinel-1 data:

- Band: C
- Polarisation: VV&VH
- Resolution: 20 m (SW)

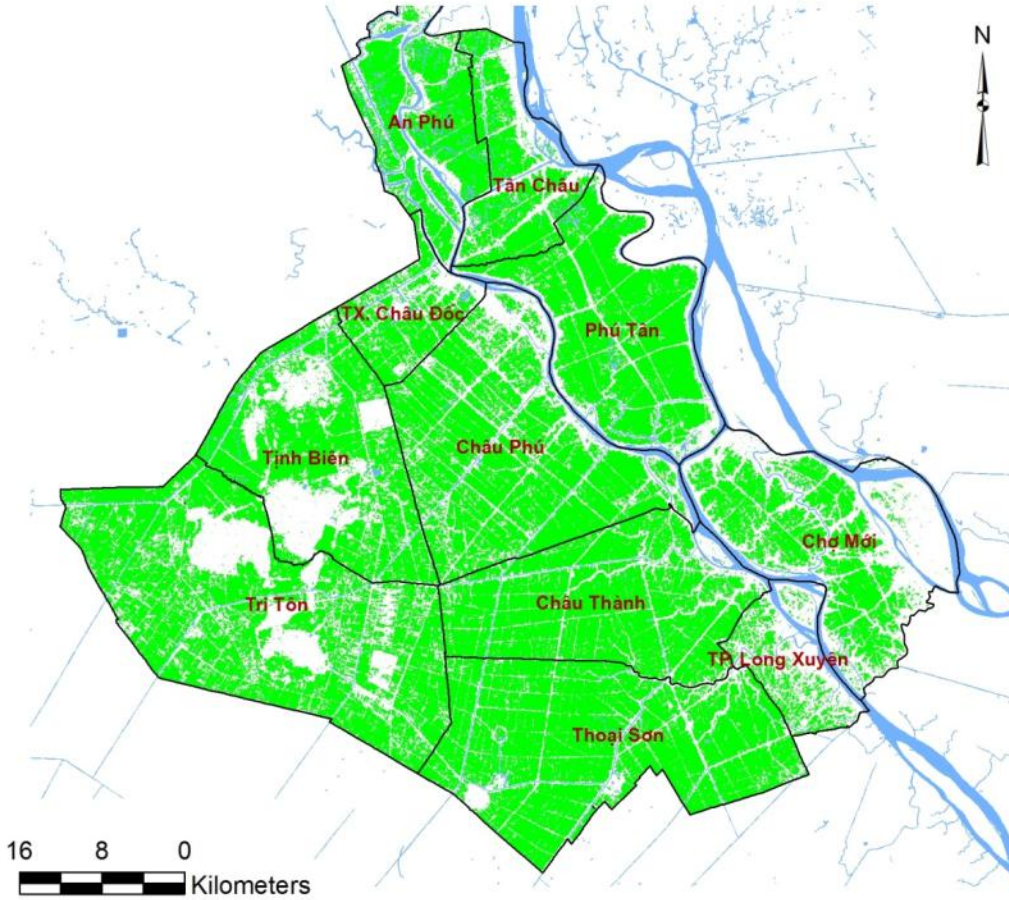
### ALOS-2 data:

- Band: L
- Polarisation: HH&HV
- Resolution: 50 m (WS) & 12.5 m (Fine)

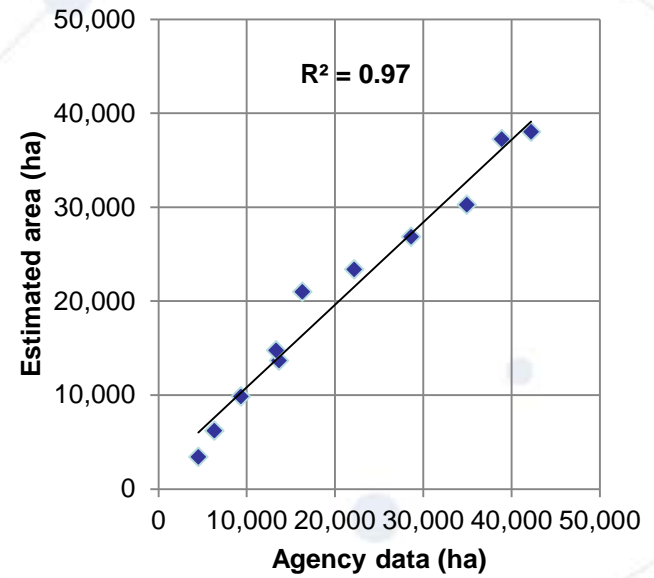


Rice parameters	Description	Equipment	
<p data-bbox="48 92 382 425">Guidelines for ground data collection for rice monitoring experiments using radar data (Thuy Le Toan)</p> <p data-bbox="48 592 343 625">General parameters</p>	Paddy variety	Ex.: IR 64	
	Method of planting	direct sowing/ transplanting	
	Sowing date	date of direct sowing or number of days after sowing	
	Transplanting date (if transplanting)	date of transplantation or the number of days after transplantation	
	Date of harvesting	if the rice has been harvested	
	Yield (kg/m <sup>2</sup> )	if the rice have been harvested	
	Plant phenological stage	Seeding, transplanting, tillering, heading, flowering, ripening, ready to harvest	
	Water layer height (cm)	if fields are flooded	stick
	Plant height (cm)	above water layer	tape
	Wet weight per m <sup>2</sup> (g)	above water biomass (moist weight by m <sup>2</sup> )	cut all plants from defined areas (min 50 x 50 cm)
Dry weight per m <sup>2</sup> (g)	objective is to measure the dry biomass per m <sup>2</sup>	Oven dry (105° during 24 hours)	
Leaf parameters (optional)	Number of leaves per stem	Few samples for each sortie	
	Leaf length (cm) Leaf width (cm)	-Photo -Xerox copy of leaves	
Panicle parameters	Moist and dry biomass of panicles per m <sup>2</sup>		

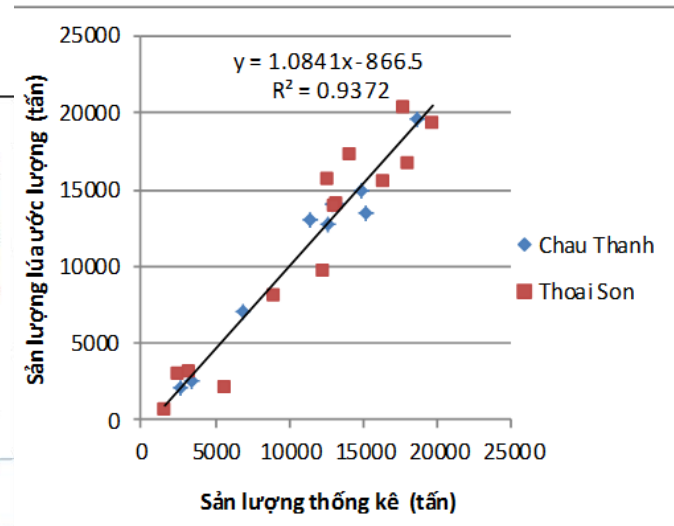
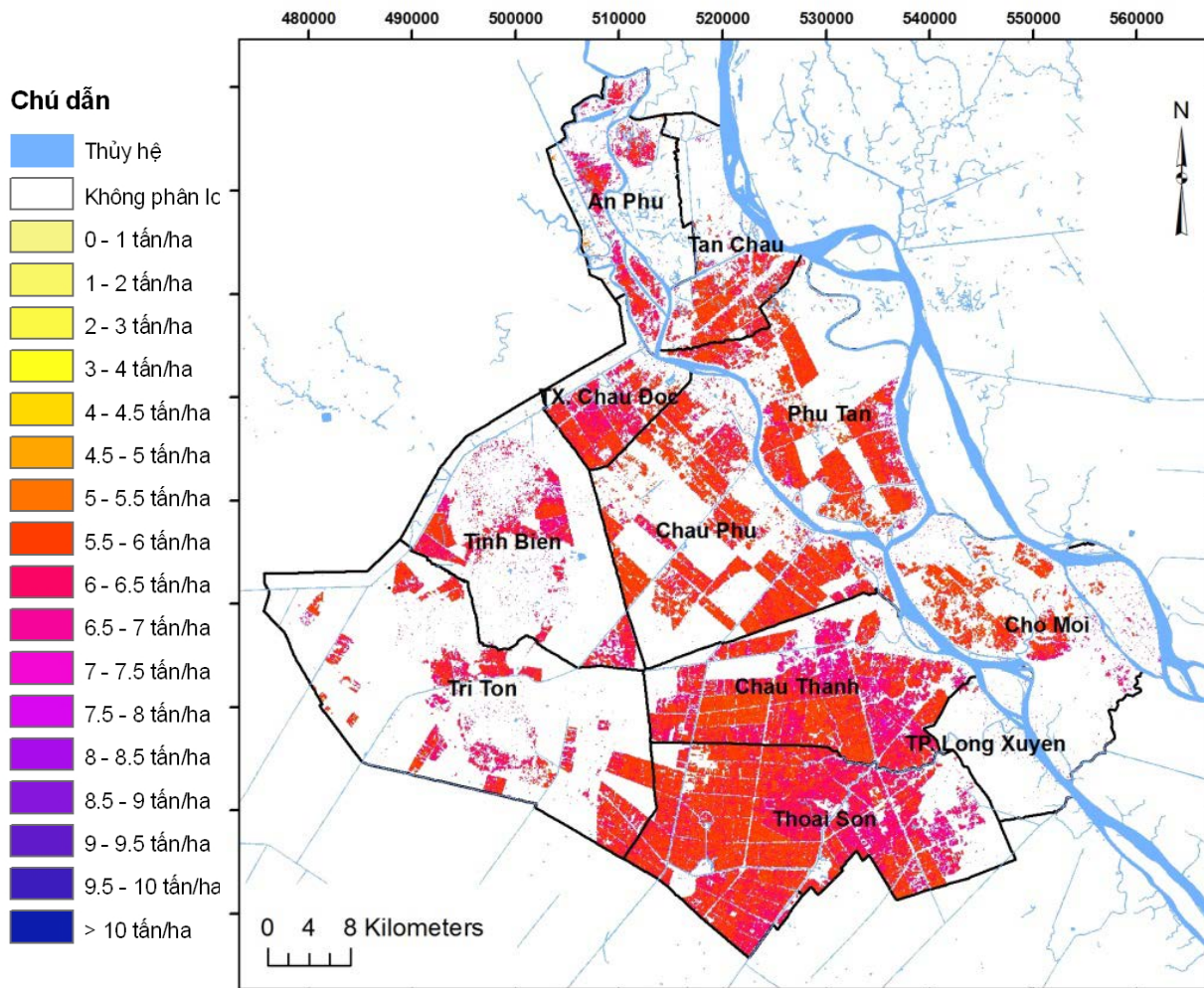




District	Agency data (ha)	Estimated area (ha)	Difference percentage (%)
An Phú	13,640	13,679	0.3
Cho Moi	13,304	14,784	11.1
Chau Phu	34,940	30,274	-13.4
Chau Thanh	28,630	26,857	-6.2
Phu Tan	22,151	23,382	5.6
Tinh Bien	16,288	21,000	28.9
Chau Doc	6,315	6,218	-1.5
Long Xuyen	4,518	3,427	-24.1
Thoai Son	38,882	37,236	-4.2
Tri Ton	42,210	38,042	-9.9
Tan Chau	9,321	9,874	5.9
<b>Total</b>	<b>230,199</b>	<b>224,774</b>	<b>-2.4</b>

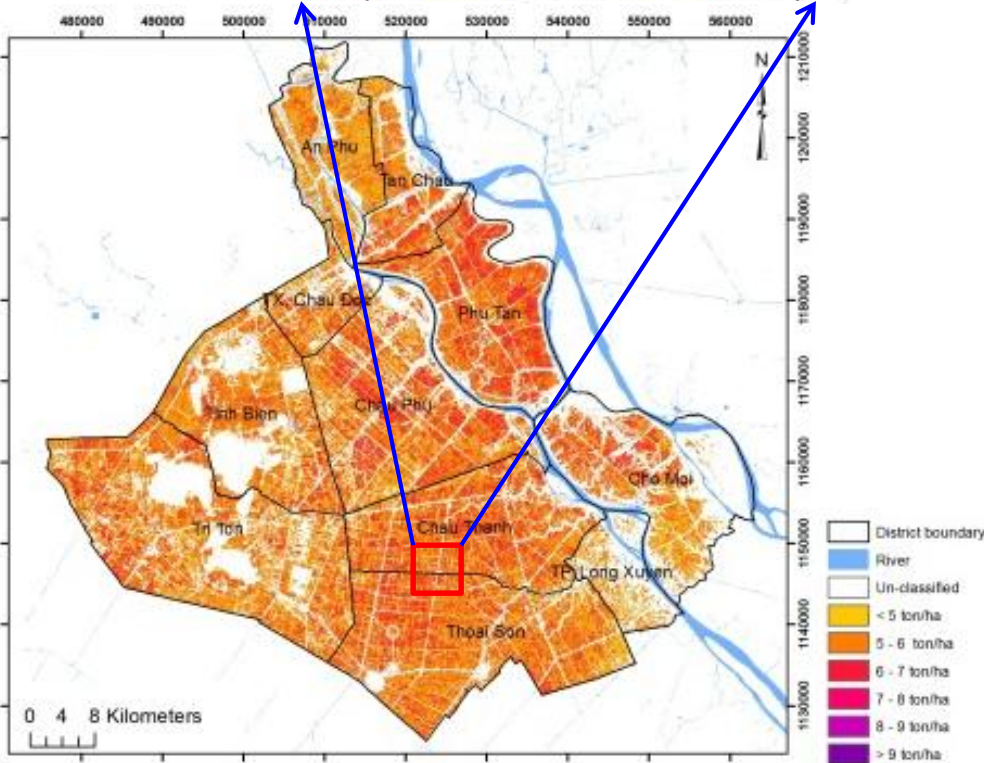
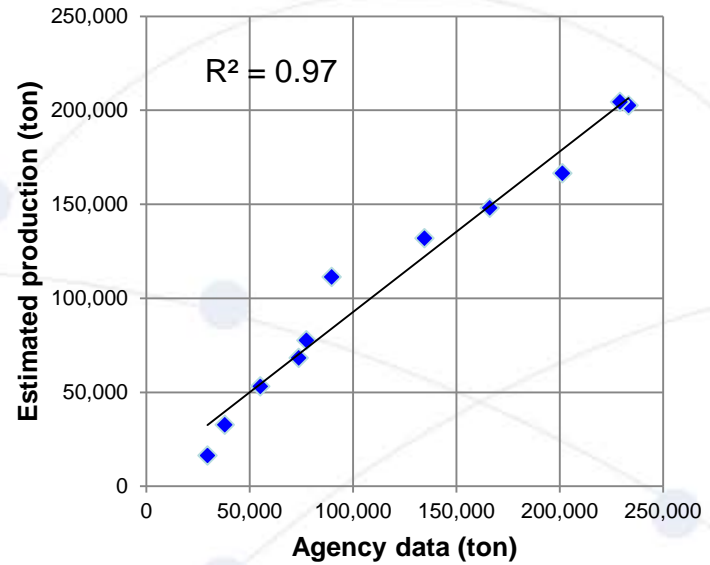
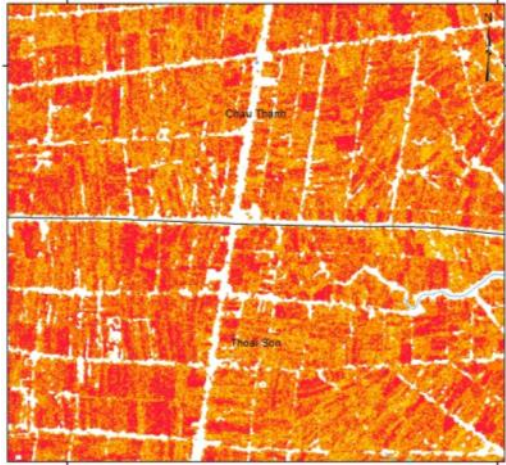


SA 2016 crop from RADARSAT-2  
(15 Apr, 09 May, 02 Jun, 26Jun, 20 Jul & 13 Aug)



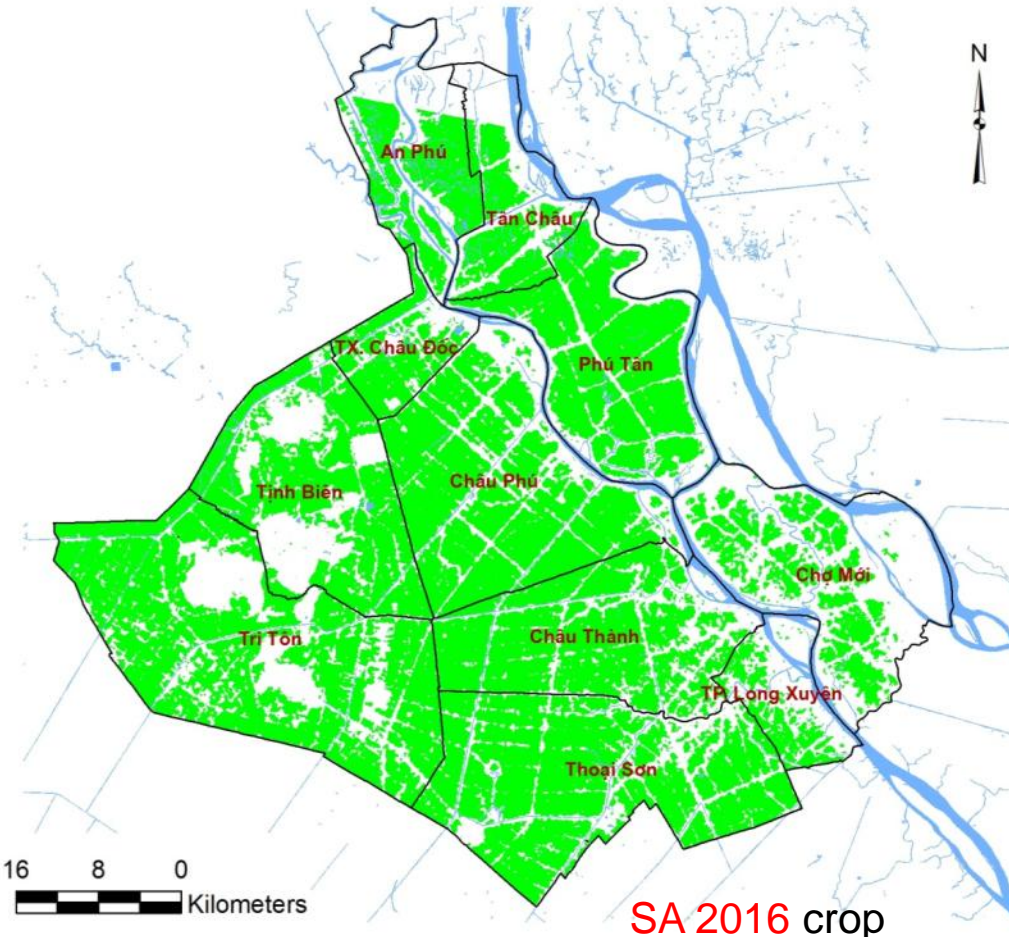
A distribution map of estimated rice yield of An Giang in AW 2013 crop using RADARSAT-2 data

A distribution map of estimated rice yield of An Giang in SA 2016 crop using RADARSAT-2 data

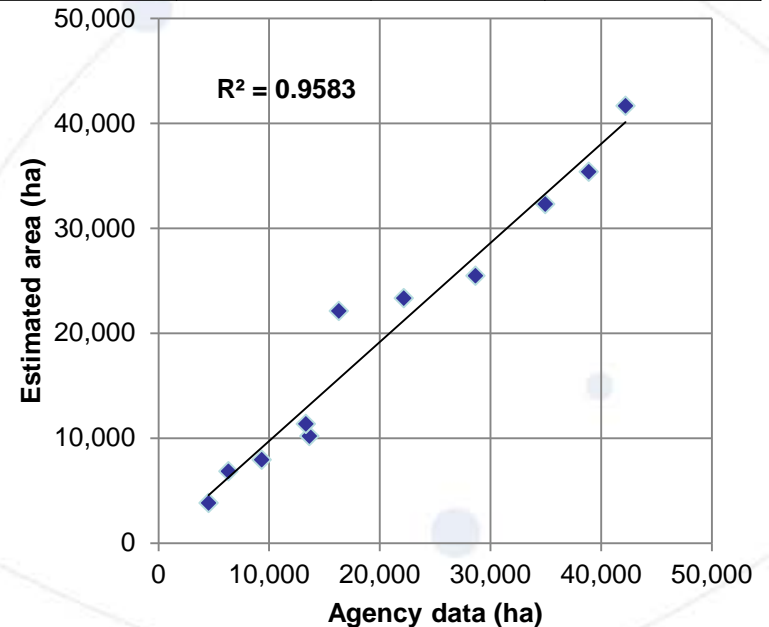


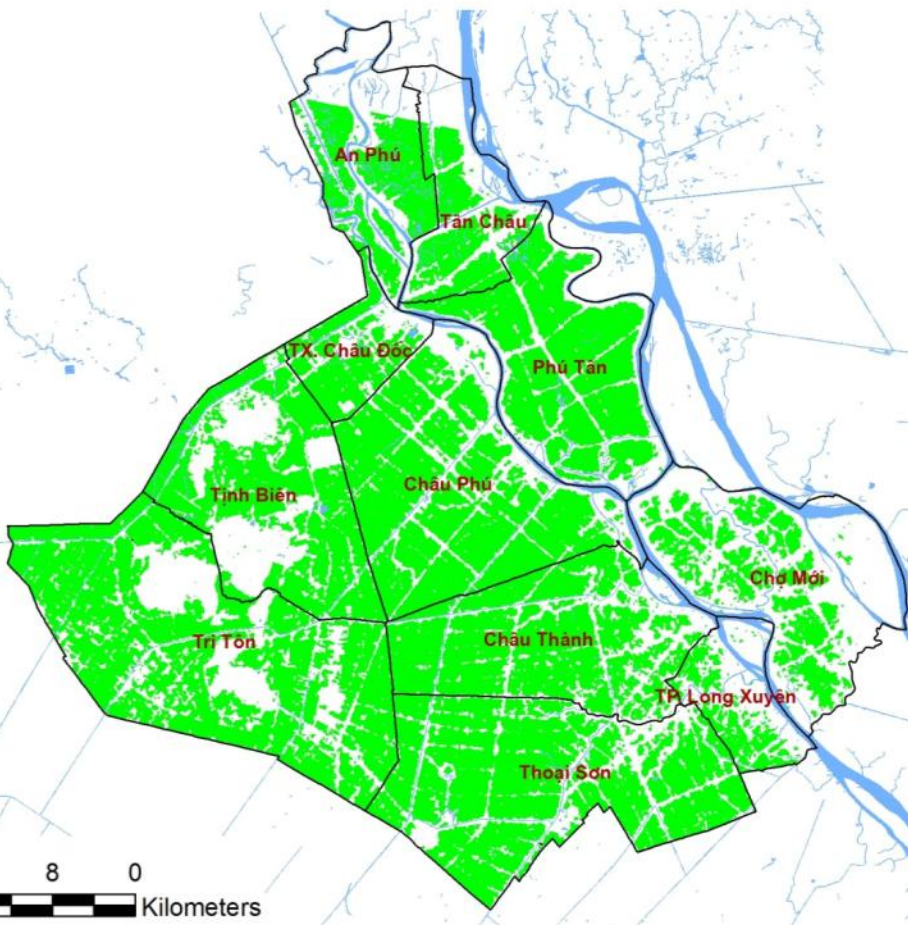
District	Agency data (ton)	Estimated production (ton)	Difference percentage (%)
An Phú	73,656	68,296	-7.3
Chợ Mới	77,296	77,720	0.5
Châu Phú	201,254	166,581	-17.2
Châu Thành	166,054	148,199	-10.8
Phú Tân	134,457	132,012	-1.8
Tịnh Biên	89,584	111,364	24.3
Châu Đốc	37,890	32,798	-13.4
Long Xuyên	29,503	16,456	-44.2
Thoại Sơn	233,292	202,704	-13.1
Tri Tôn	229,200	204,518	-10.8
Tân Châu	54,994	53,099	-3.4
<b>Total</b>	<b>1,325,946</b>	<b>1,213,746</b>	<b>-8.5</b>

District	Agency data (ha)	Estimated area (ha)	Difference percentage (%)
An Phu	13,640	10,208	-25.2
Cho Moi	13,304	11,351	-14.7
Chau Phu	34,940	32,294	-7.6
Chau Thanh	28,630	25,465	-11.1
Phu Tan	22,151	23,329	5.3
Tinh Bien	16,288	22,137	35.9
Chau Doc	6,315	6,834	8.2
Long Xuyen	4,518	3,819	-15.5
Thoai Son	38,882	35,387	-9.0
Tri Ton	42,210	41,661	-1.3
Tan Chau	9,321	7,937	-14.9
<b>Total</b>	<b>230,199</b>	<b>224,774</b>	<b>-2.4</b>

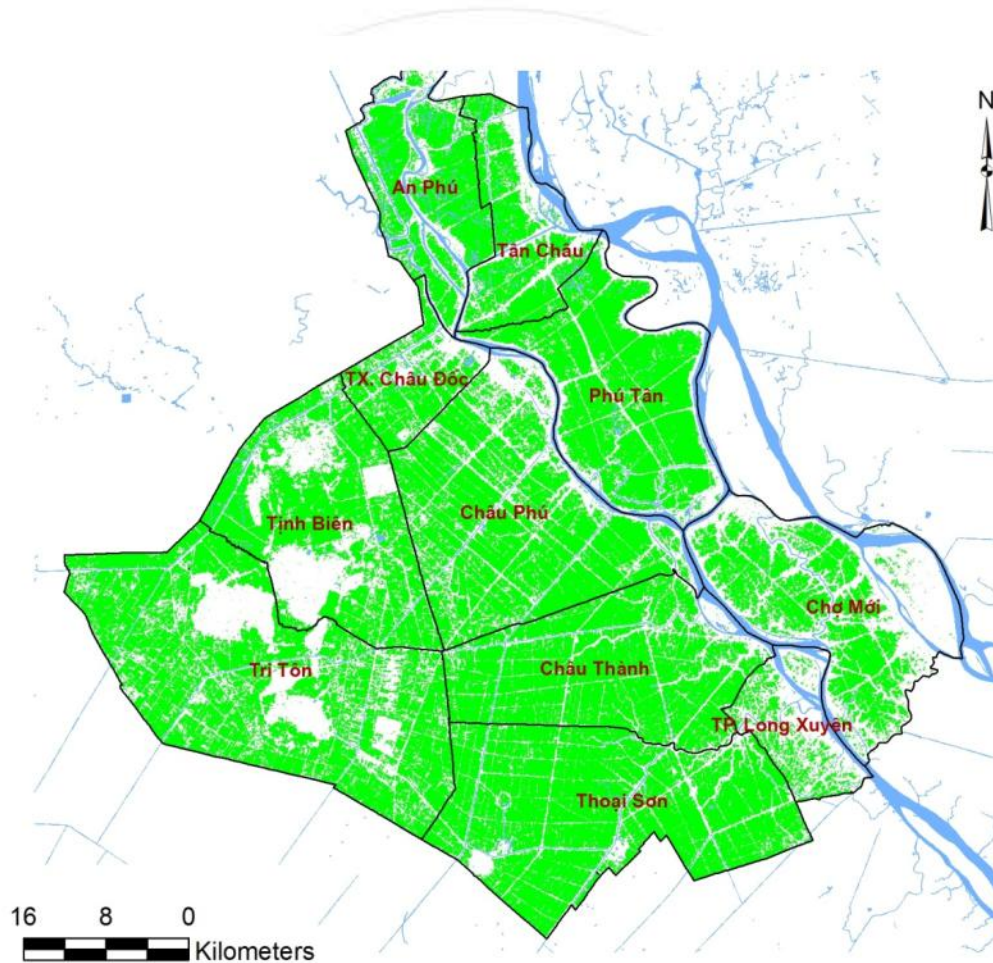


SA 2016 crop

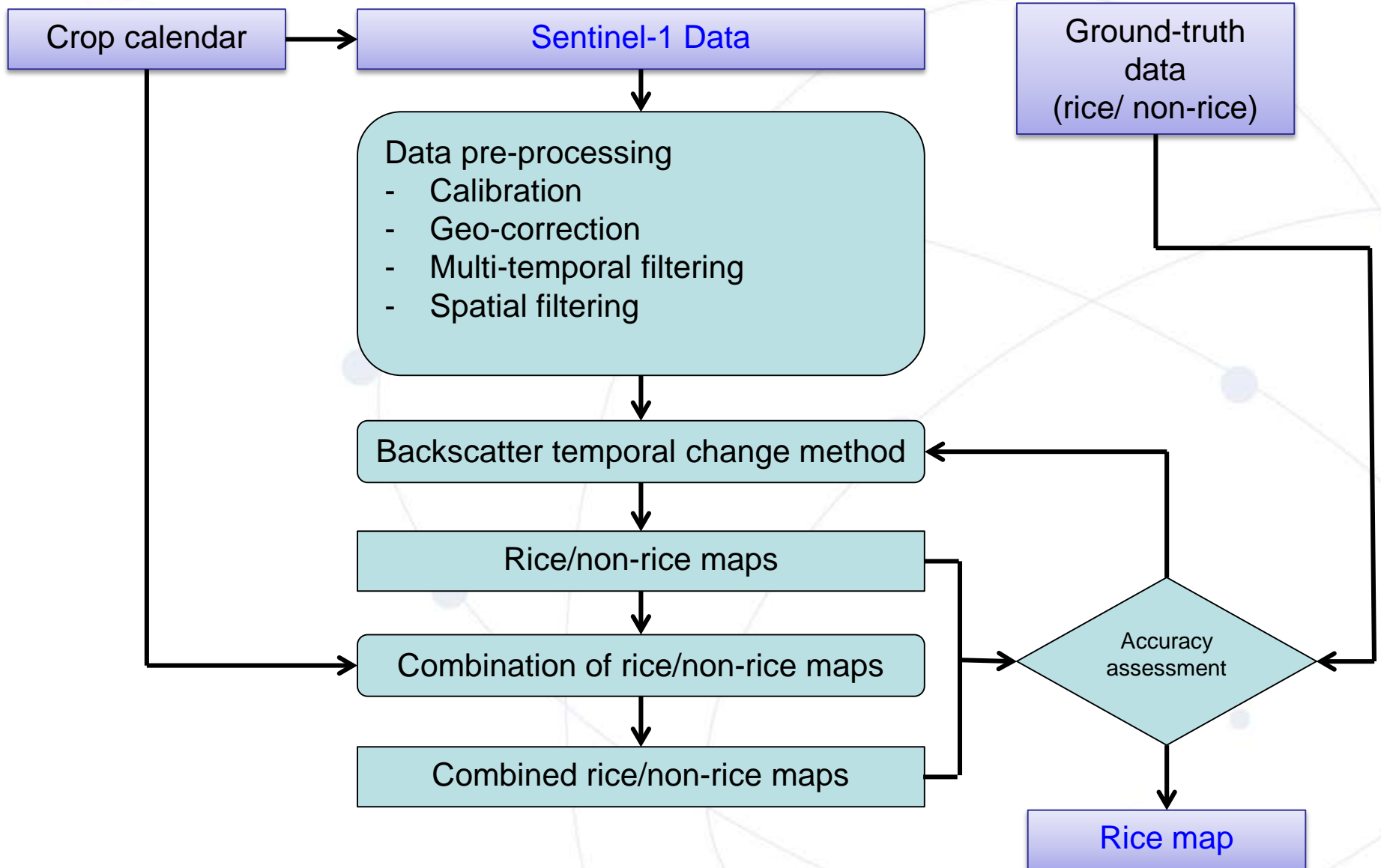


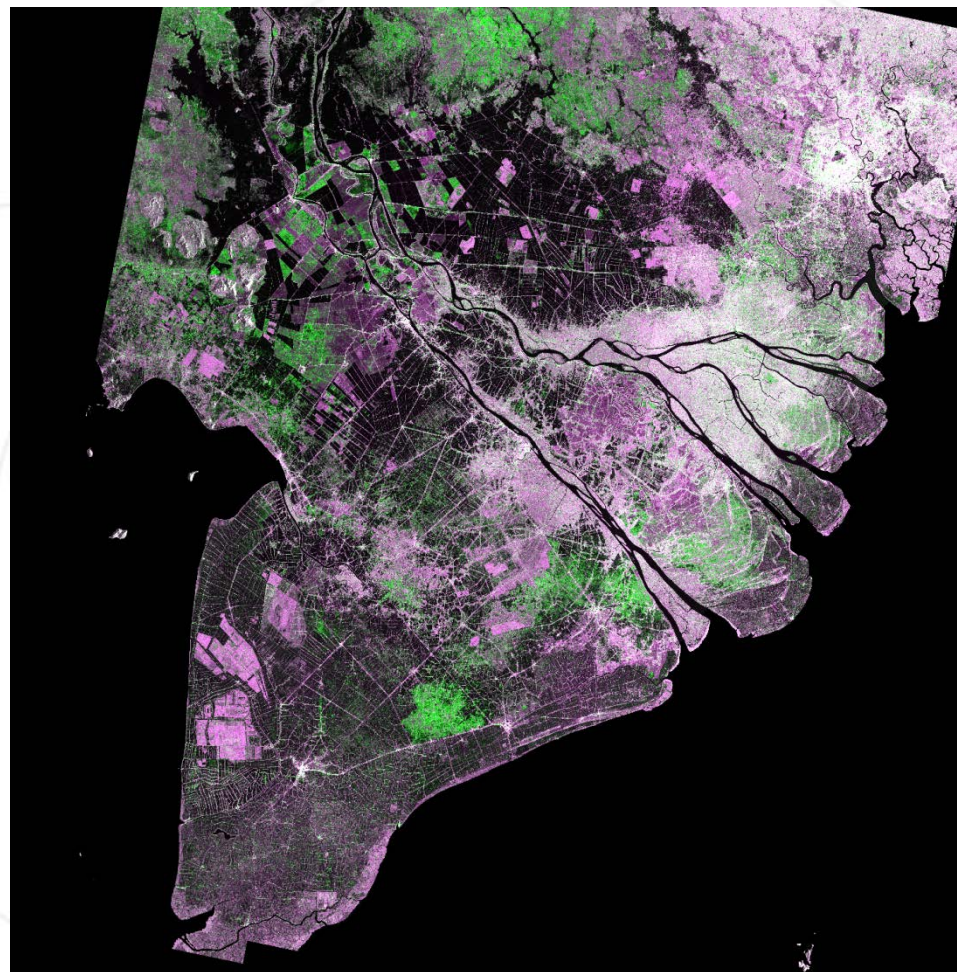
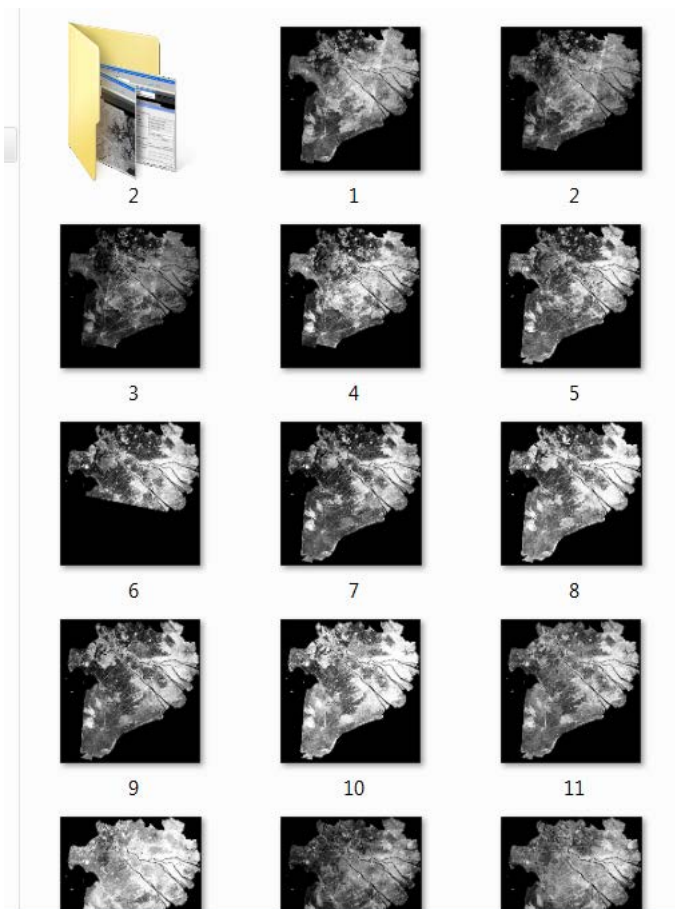


SA 2016 crop (using S-1 images)

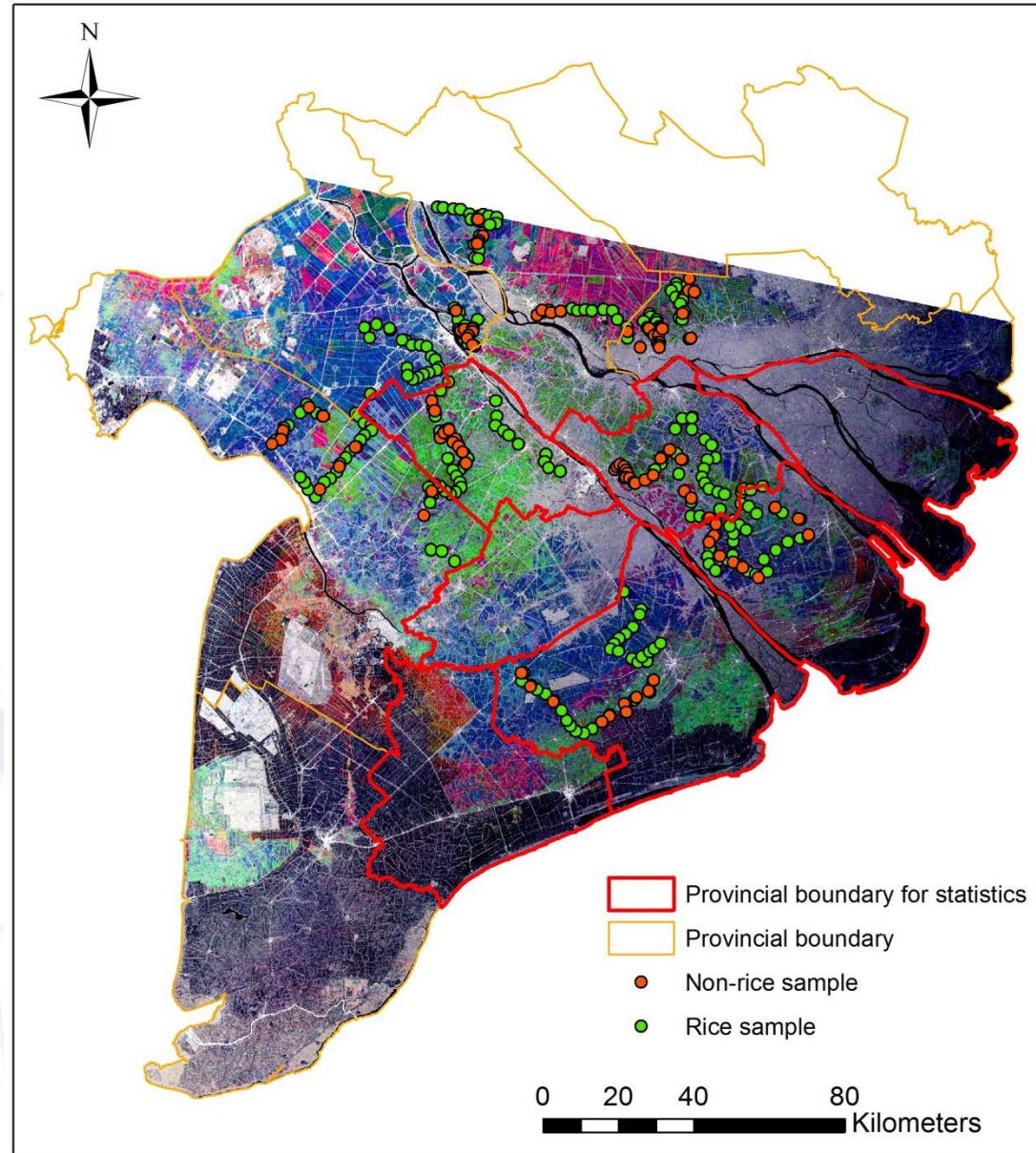


SA 2016 crop (using R-2 images)





Every 12 days except few gaps



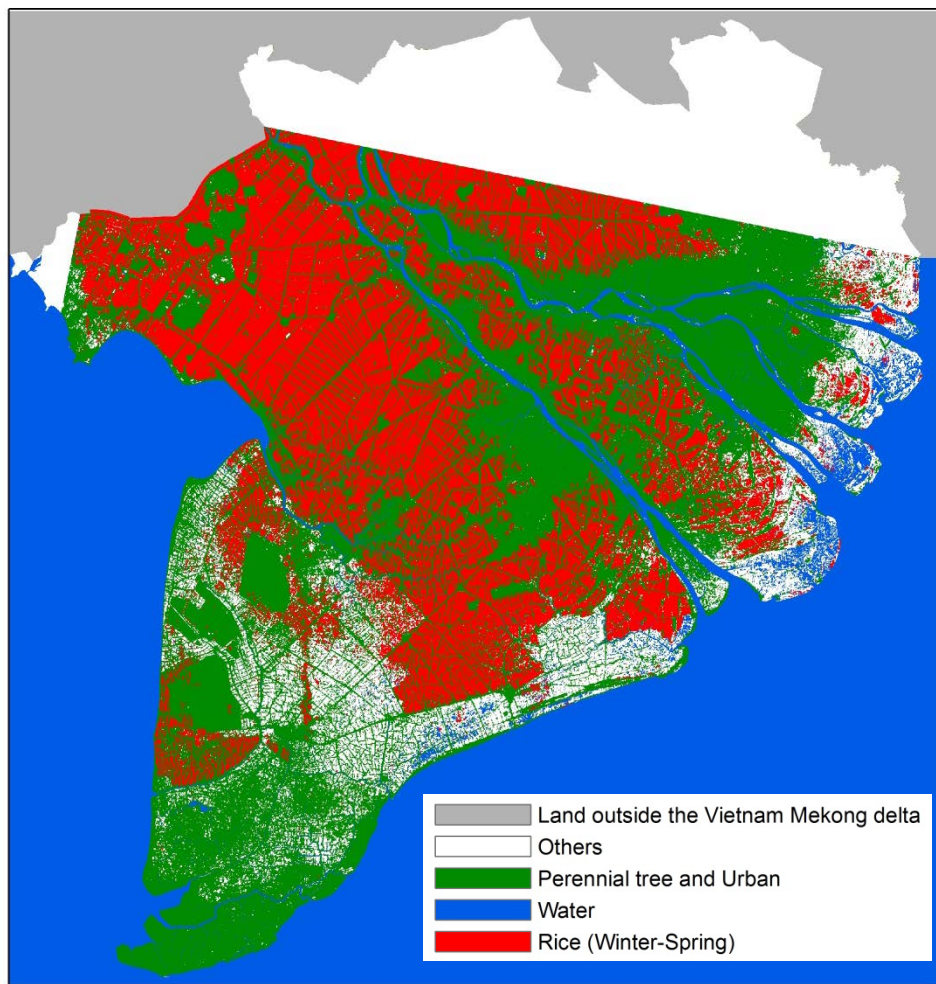
Ground data: 241 rice samples and 93 non-rice samples;

**R:** 05/01/2017,

**G:** 10/02/2017,

**B:** 12/03/2017



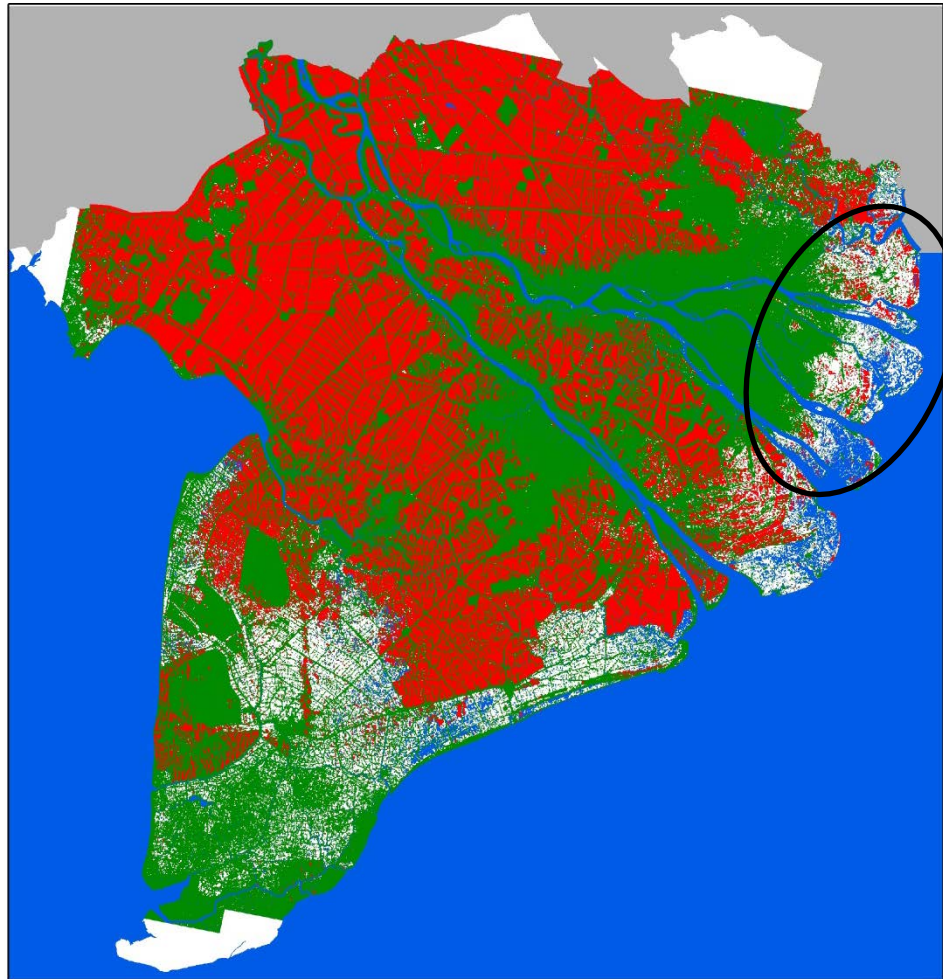
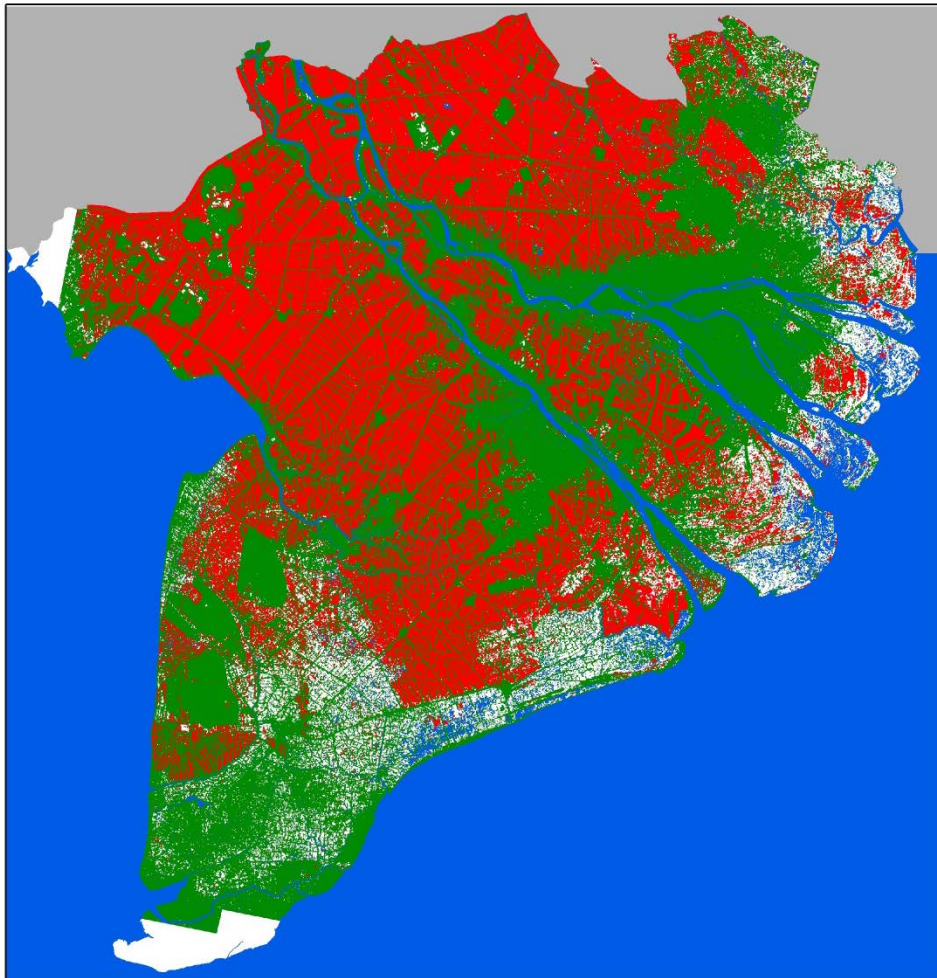


Map of WS Rice 2017

Ground truth	non-rice	rice	Total
Class			
non-rice	90	12	102
rice	3	229	232
Total	93	241	334
Overall Accuracy = 96 %			
Kappa Coefficient = 0.89			

Map of WS Rice 2015

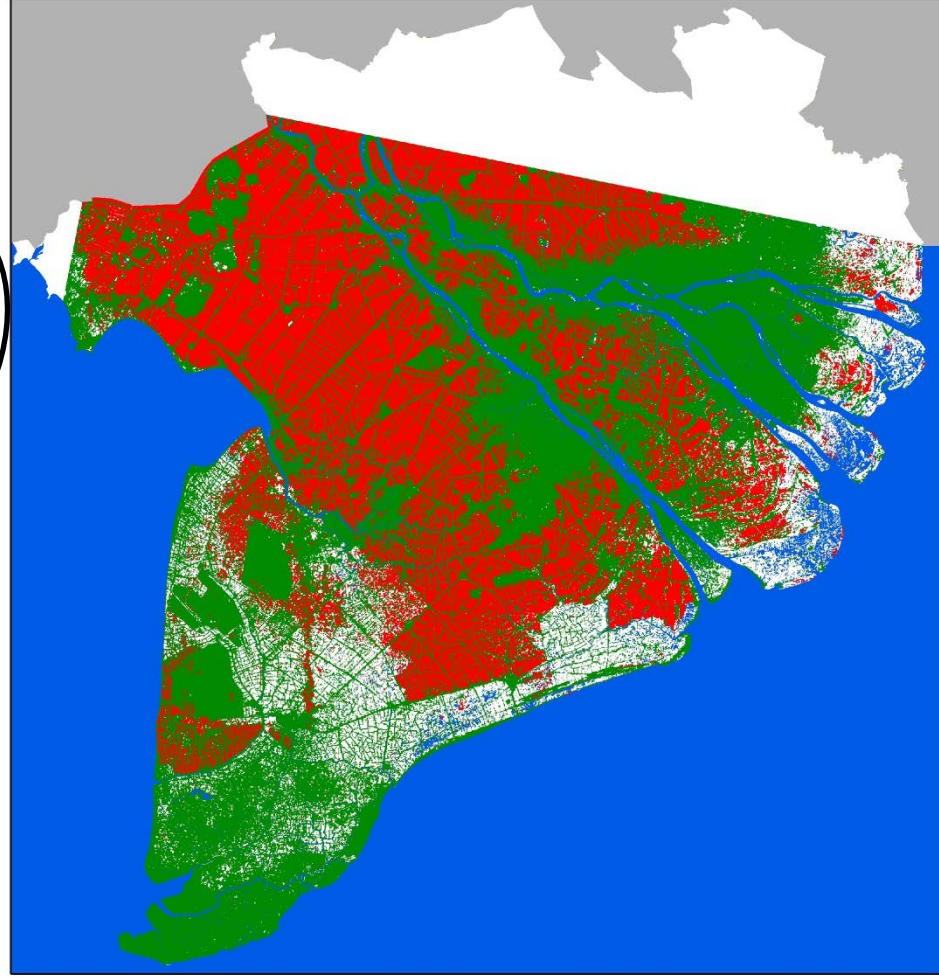
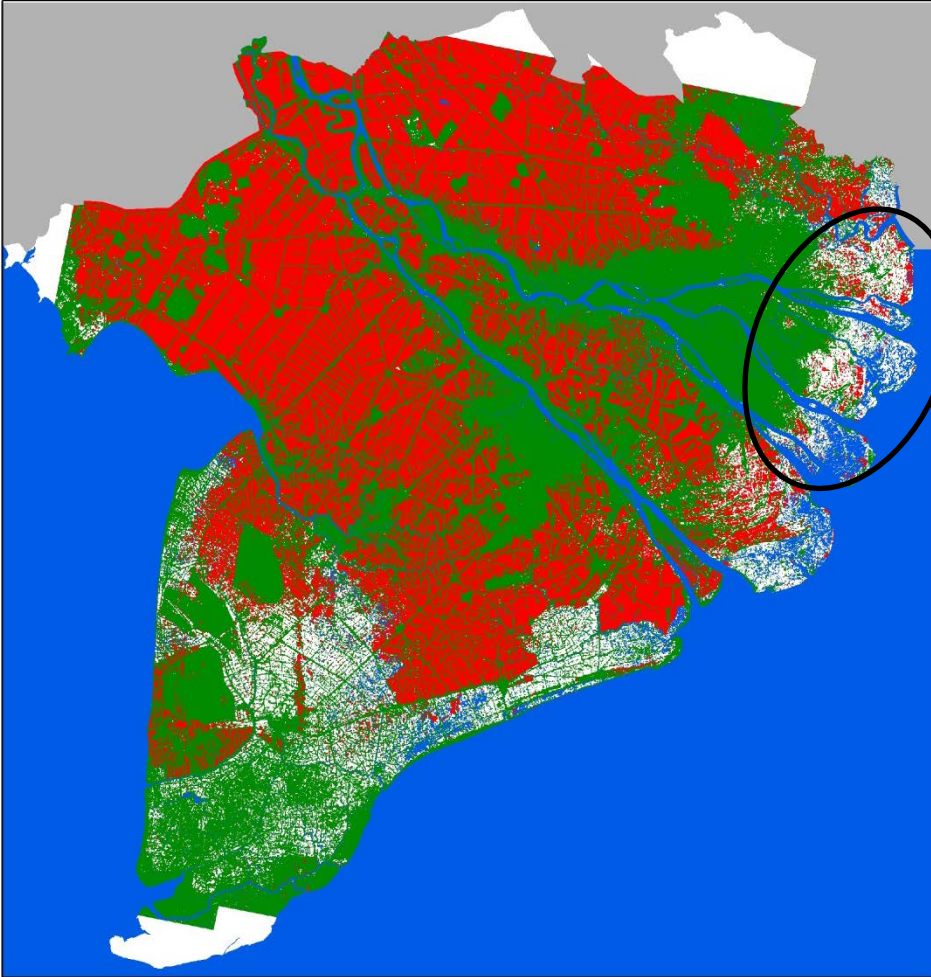
Map of WS Rice 2016



Reduced area in 2016 caused by shortage of water and saline water intrusion

Map of WS Rice 2016

Map of WS Rice 2017



Reduced area in 2016 caused by shortage of water and saline water intrusion

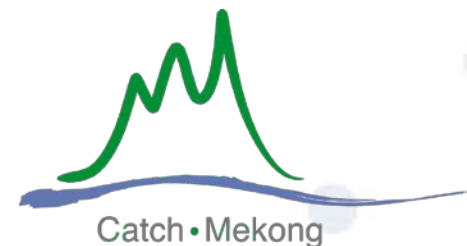
- **VNRice** (Applied research on the multi-temporal, multi-resolution optical and radar remote sensing data for rice planted area monitoring and rice yield, production estimation in the Mekong Delta and Red River Delta)

07/2017-12/2019, State level project

Rice crop area maps; yield & production estimation; crop calendars/  
crop growth status

- **Catch Mekong** (Eco-environmental Changes in Vietnamese Mekong Delta & Impact Assessment of Uncontrolled Economic Activities from Mekong Basin)

04/2017-04/2020, State level project




- ❑ Extend the target area and increase the observation frequency;
- ❑ Validation activities for the rice crop estimation;
- ❑ Capacity building activities for end user.
- ❑ Information dissemination.


## CROP MONITOR FOR AMIS

### NO. 41


July 2017

The Group on Earth Observations' Global Agricultural Monitoring (GEOGLAM) initiative developed the Crop Monitor whose objective is to provide AMIS with an international and transparent multi-source, consensus assessment of crop growing conditions, status, and agro-climatic conditions, likely to impact global production. This activity covers the four primary crop types (wheat, maize, rice, and soy) within the main agricultural producing regions of the AMIS countries (G20+7). The Crop Monitor reports provide cartographic and textual summaries of crop conditions as of the 26th of each month, according to crop type. There is another Crop Monitoring Initiative called the Early Warning Crop Monitor ([geoglam-crop-monitor.org](http://geoglam-crop-monitor.org)), which has grown out of this initiative.







**AMIS**  
Agricultural Market Information System



**GROUP ON EARTH OBSERVATIONS**



**Crop Monitor**  
a geoglam initiative



**GEOGLAM**  
Global Agricultural Monitoring

- **Place:** Hanoi Head quarter office
  - **Applications:**
    - Rice monitoring
    - Forest monitoring
    - Water quality
  - **Infrastructure:** by help of ISMG (I. M. Systems Group, Inc.)
  - **Satellite Data:**
    - Landsats from USGS
    - ALOS from JAXA
    - Sentinel-1&-2 from ESA
  - **Software:**
    - Supports from CSIRO/CEOS
- Pilot setup – 6-7 April 2017
  - New Computer system by June, 2017
  - Data developer training: July-Aug., 2017
  - Technical development: Aug.-Oct., 2017
  - Testing: Nov. 2017
  - **System working and workshop:** Dec. 2017

VAST: Vietnam Academy of Science and Technology

VNSC: Vietnam National **Satellite** Center

Vietnam National **Space** Center (Effectived from 17/07/2017)

STAC: Vietnam Southern **Satellite** Technology Application Center

Ho Chi Minh City **Space** Technology Application Center



**Hanoi  
(2017)**



**Hoa Lac  
(2019)**

Hoàng Sa



**Nha Trang**



**Nha Trang  
(2016)**

Trường Sa



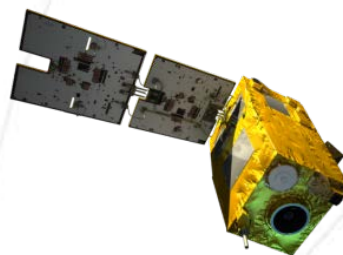
**Hochiminh City  
(2020)**

Phú Quốc

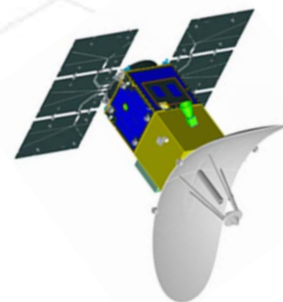
Côn Đảo

Mekong Data cube:  
pilot cube of **Vietnam  
Data cube**: Landsat,  
Sentinel-1&-2, ALOS-2

# *Thank you*



**VNREDSat-1**  
2013



**LOTUSAT-1**  
2020

Nguyen Lam-Dao  
HCMC Space Technology Application Center  
[ldnguyen@vnsc.org.vn](mailto:ldnguyen@vnsc.org.vn)