Land Use/Cover Changes, Environment and Emissions
in South/Southeast Asia – An International Regional Science Meeting
Johor Bahru, 22-24 July 2019

Rice monitoring in Vietnam and 2019 CEOS Chair Initiative

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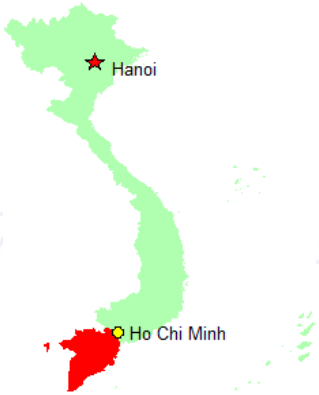
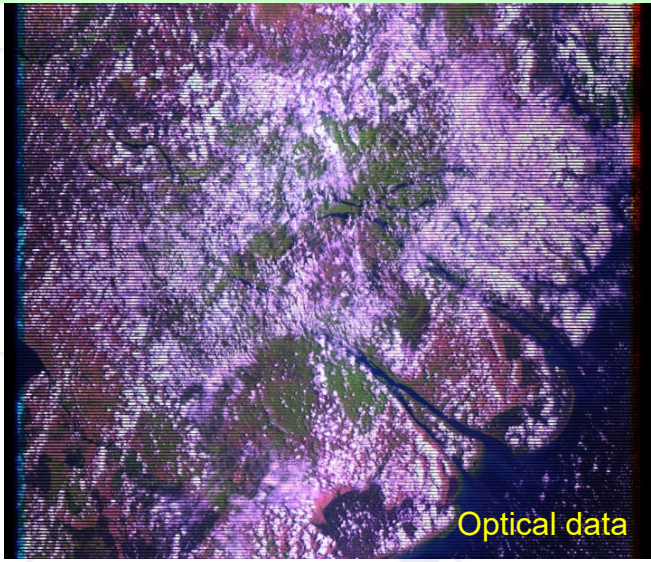
Introduction

Rice in Vietnam mainly grown in the Mekong Delta and Red River Delta





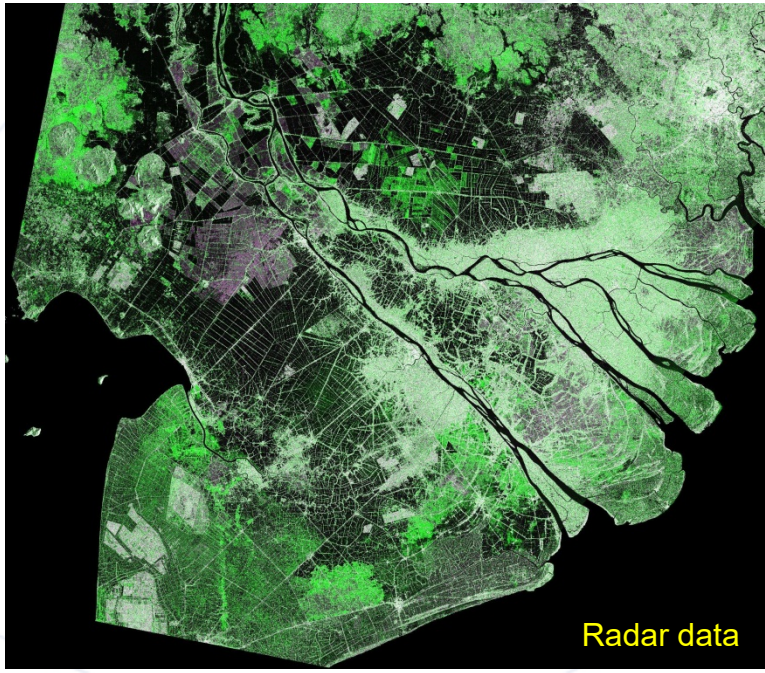
Mekong Delta (Source: GSO, 2016)

- Area: 40,82 Km^2 (1/8)
- Population: 17.66 M (~1/5)
- MD accounts for more than half (23.8/43.2 Mt) of the country's rice production (>1/2)

MD is one of the most affected regions in the world by global warming.

Studies need to be conducted to quantify the changes observed by satellites in LULC, in cultural practices, etc.

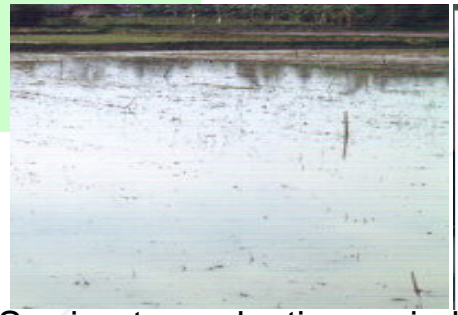
→ **Food security**



Introduction

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

Main rice-based cropping systems in the MD



Sowing-transplanting period

Vegetative stage

Reproductive stage

Ripening stage

Pictures of rice growing stages

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

Main rice seasons in An Giang province, Mekong Delta

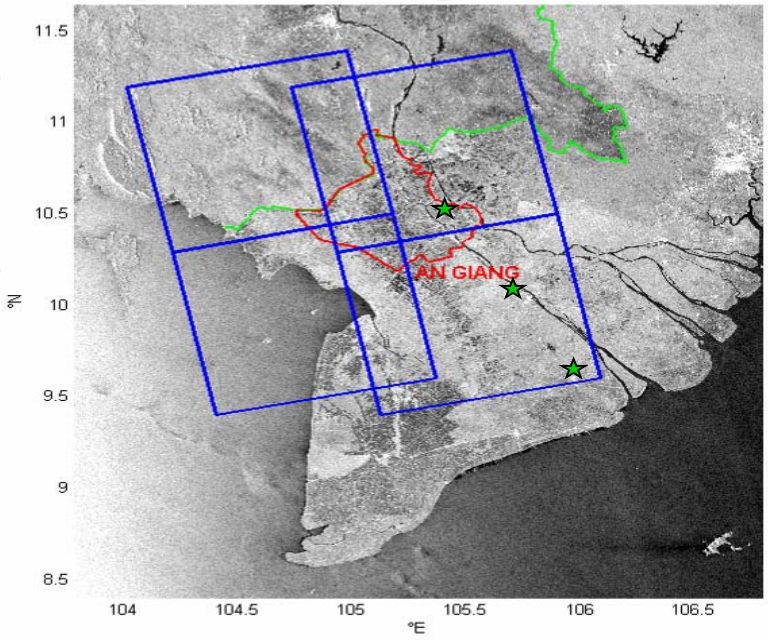
Introduction

Previous rice projects:

- Data used:
  - ✓ ERS2-SAR data, 1997-1998;
  - ✓ ENVISAT-ASAR data, 2007-2008;
  - ✓ TerraSAR-X & ENVISAT-ASAR data, 2010-2011;
  - ✓ COSMO-SkyMed, 2013.
- Rice mapping: Temporal change measurement, Single-date mapping algorithm
- Yield estimation model: Statistical model, Agro-meteorological model (AMM)

On-going rice projects: VNRice & GEORice

- Data used:
  - ✓ Sentinel-1,
  - ✓ RADARSAT-2,
  - ✓ ALOS-2,
  - ✓ Landsat-8, Sentinel-2, MODIS

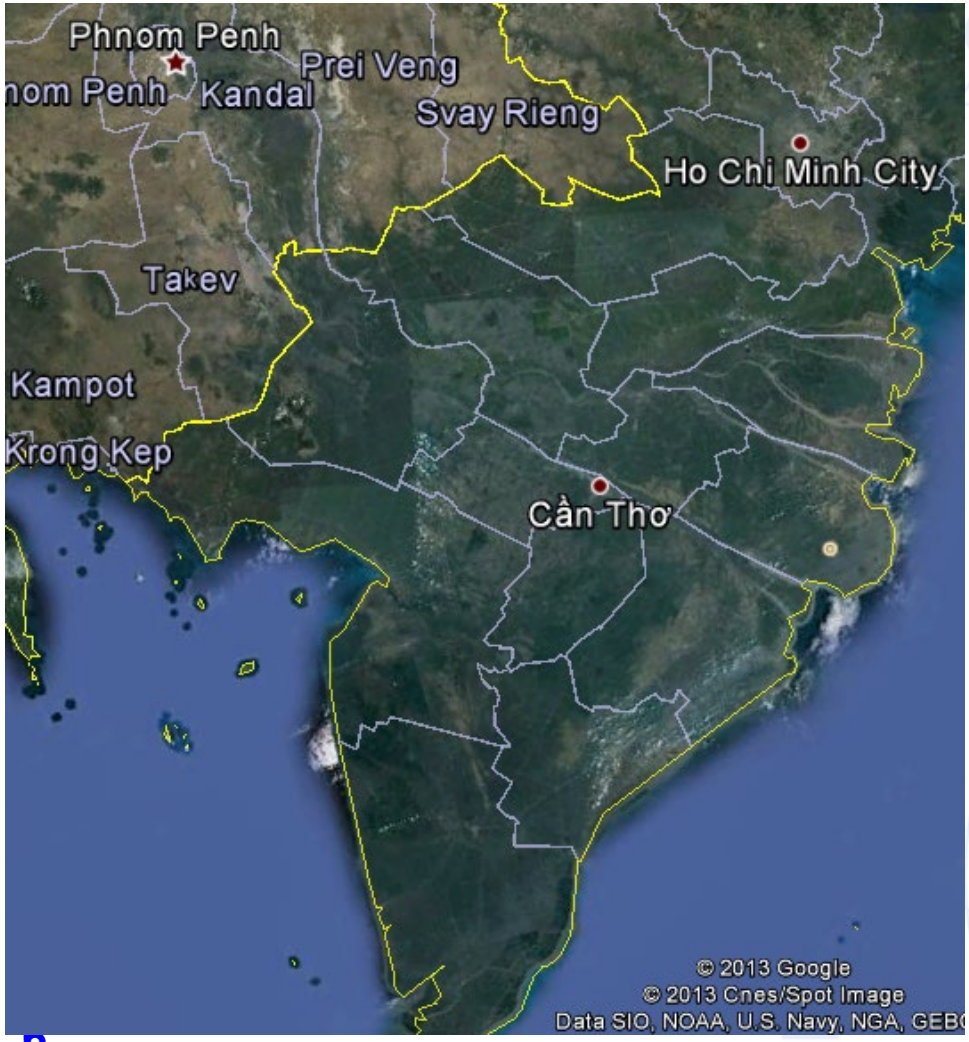


Objectives

To evaluate the use of remote sensing data in rice monitoring & yield estimation, towards an operational system for rice crop inventory in Vietnam.

Research works – Asia-RiCE (2013 -)

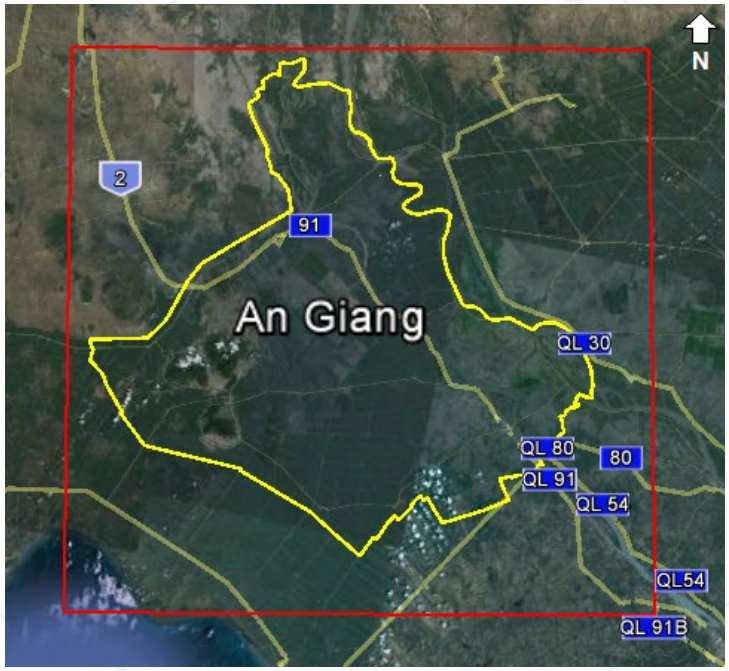
Technical Demonstrator Site – Mekong Delta, VN

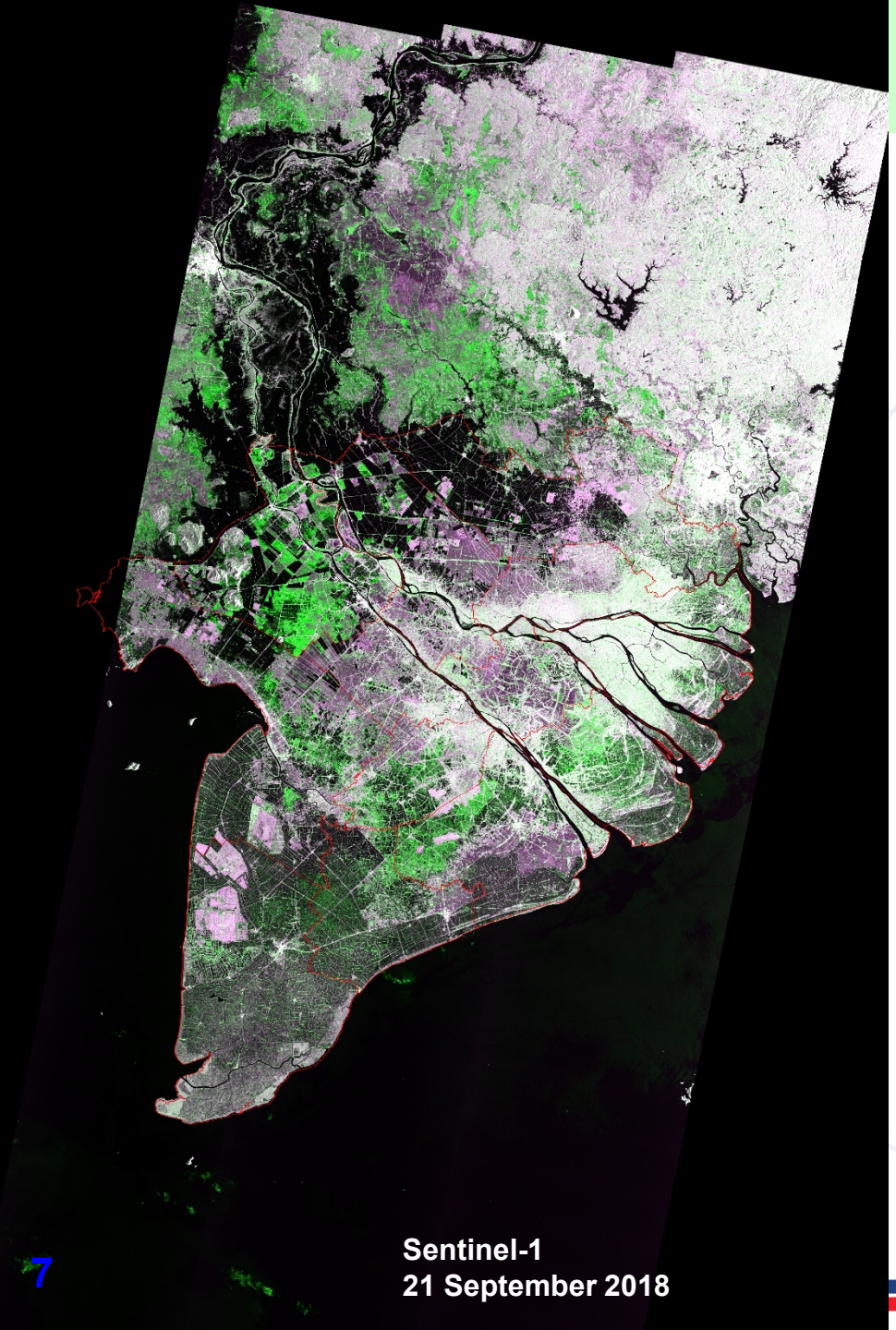


An Giang province, Mekong Delta, Vietnam

Geographic coordinates:

UL: 10°58'47.38"N, 104°44'39.51"E,
UR:10°58'35.84"N, 105°40'12.84"E
LR: 10°05'24.65"N, 105°40'15.36"E,
LL: 10°05'45.13"N, 104°44'23.41"E





Data set

SAR data received:

COSMO-SkyMed: Aug 2013 – Feb 2014

RADARSAT-2: Aug 2013 – present

Sentinel-1: Aug 2014 – present

ALOS-2: Nov 2014 – present

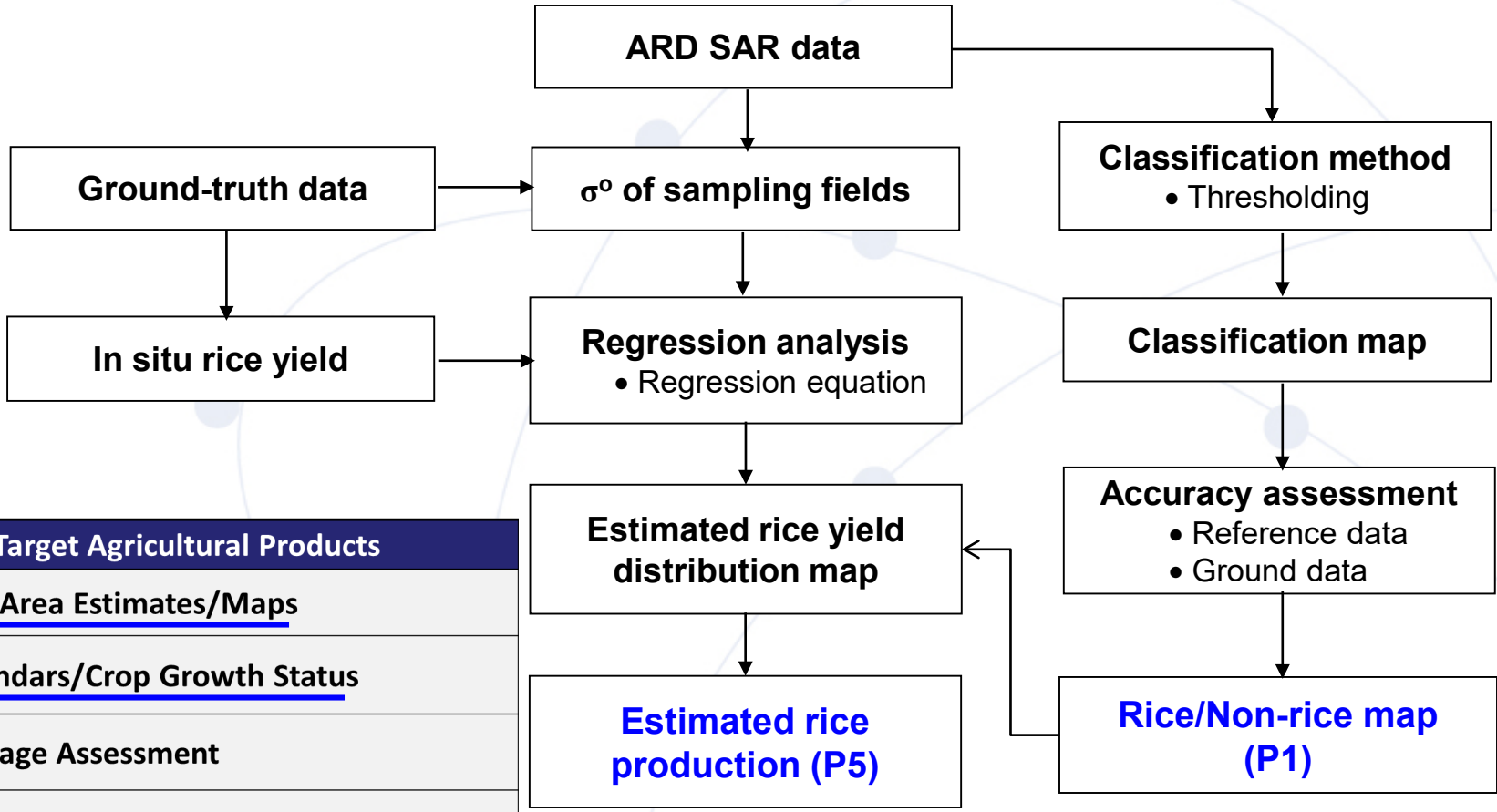
COSMO-SkyMed data:
- Band: X
- Polarisation: HH&VV
- Resolution: 20 m (StripMap PINGPONG)

RADARSAT-2 data:
- Band: C
- Polarisation: VV&VH
- Resolution: 10 m (Wide Fine)

Sentinel-1 data:
- Band: C
- Polarisation: VV&VH
- Resolution: 20 m (IW)

ALOS-2 data:
- Band: L
- Polarisation: HH&HV
- Resolution: 50 m (WS) & 12.5 m (Fine)

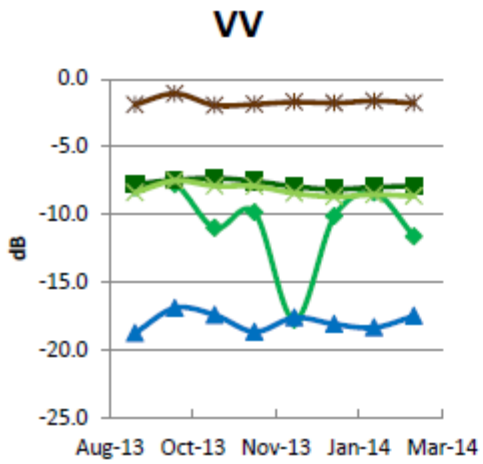
Methods

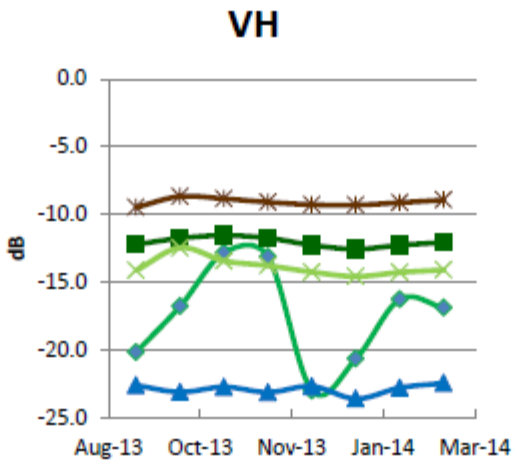


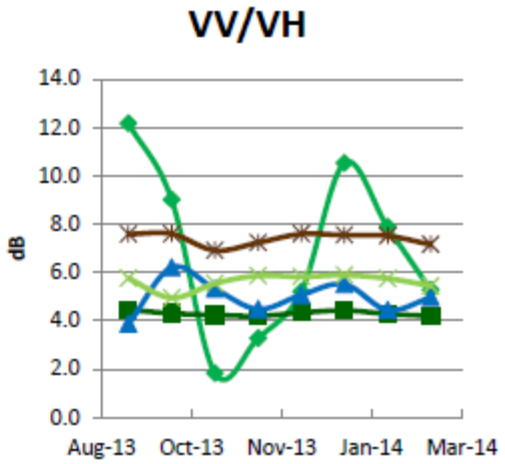
ID	Target Agricultural Products
P1	Rice Crop Area Estimates/Maps
P2	Crop Calendars/Crop Growth Status
P3	Crop Damage Assessment
P4	Agro-meteorological Information Products
P5	Production Estimation and Forecasting

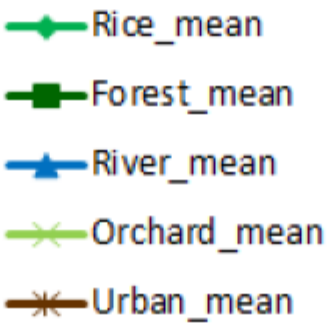
Asia-RiCE products

Methods







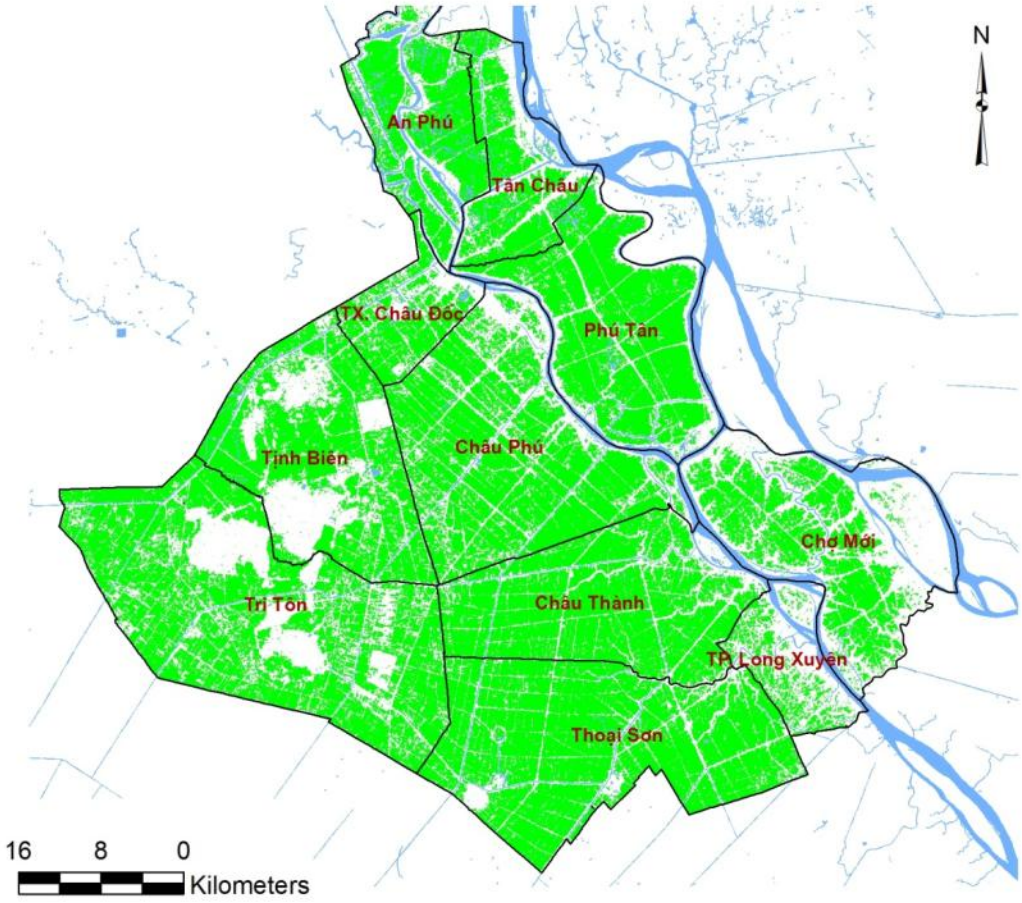


RADARSAT-2 data:

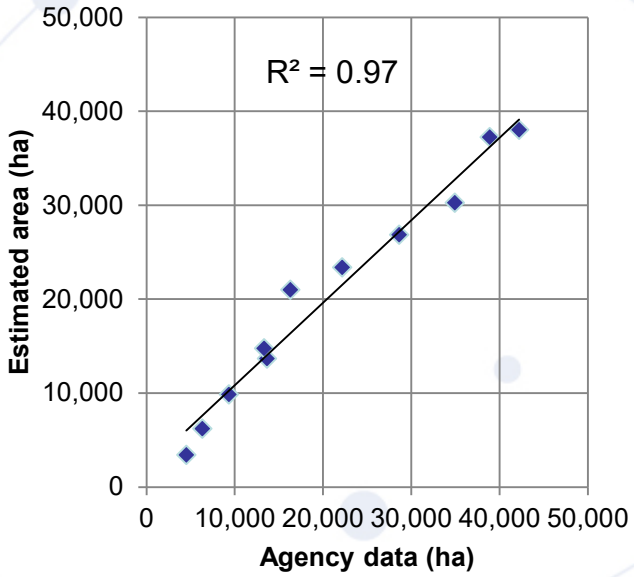
- Band: C
- Polarisation: VV&VH
- Resolution: 10 m (Wide Fine)

Data set at provincial scale

District name	Agency data (ha)	Estimated area (ha)	Percentage error (%)
An Phu	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
Total	**230,199**	**224,774**	**-2.4**

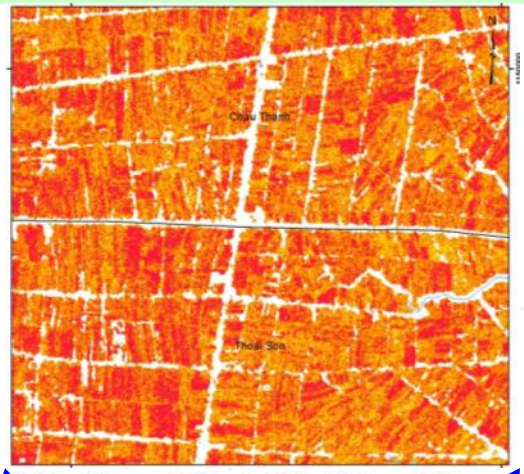


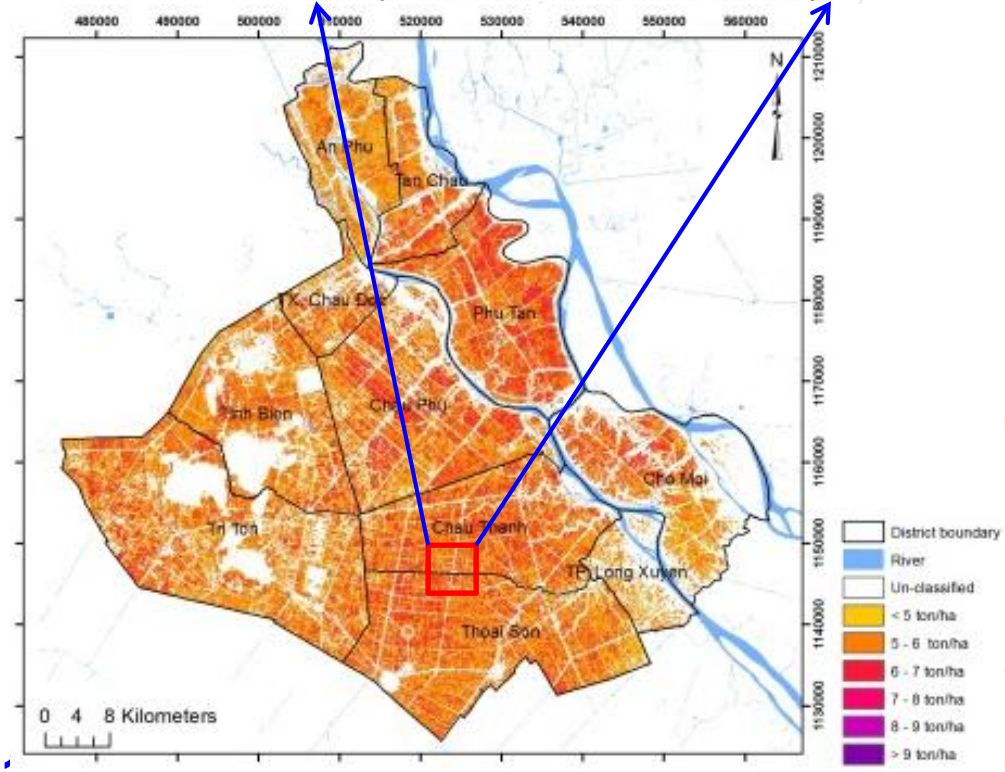
SA 2016 crop from RADARSAT-2
(15 Apr, 09 May, 02 Jun, 26Jun, 20 Jul & 13 Aug)

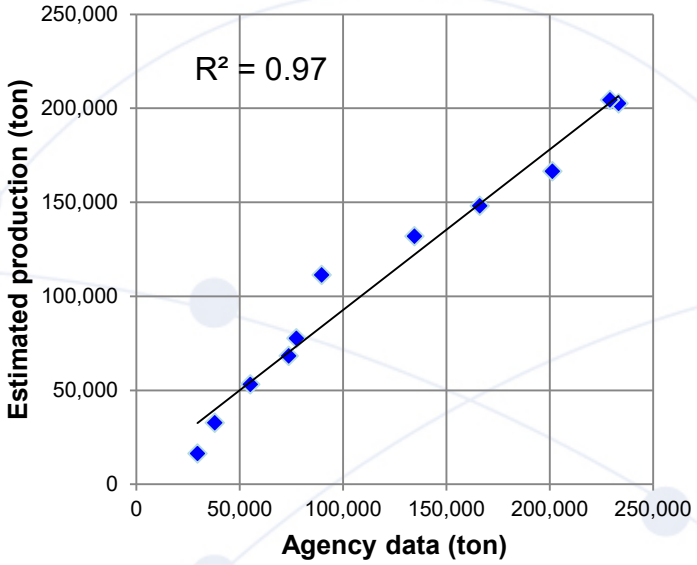


Data set at provincial scale

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



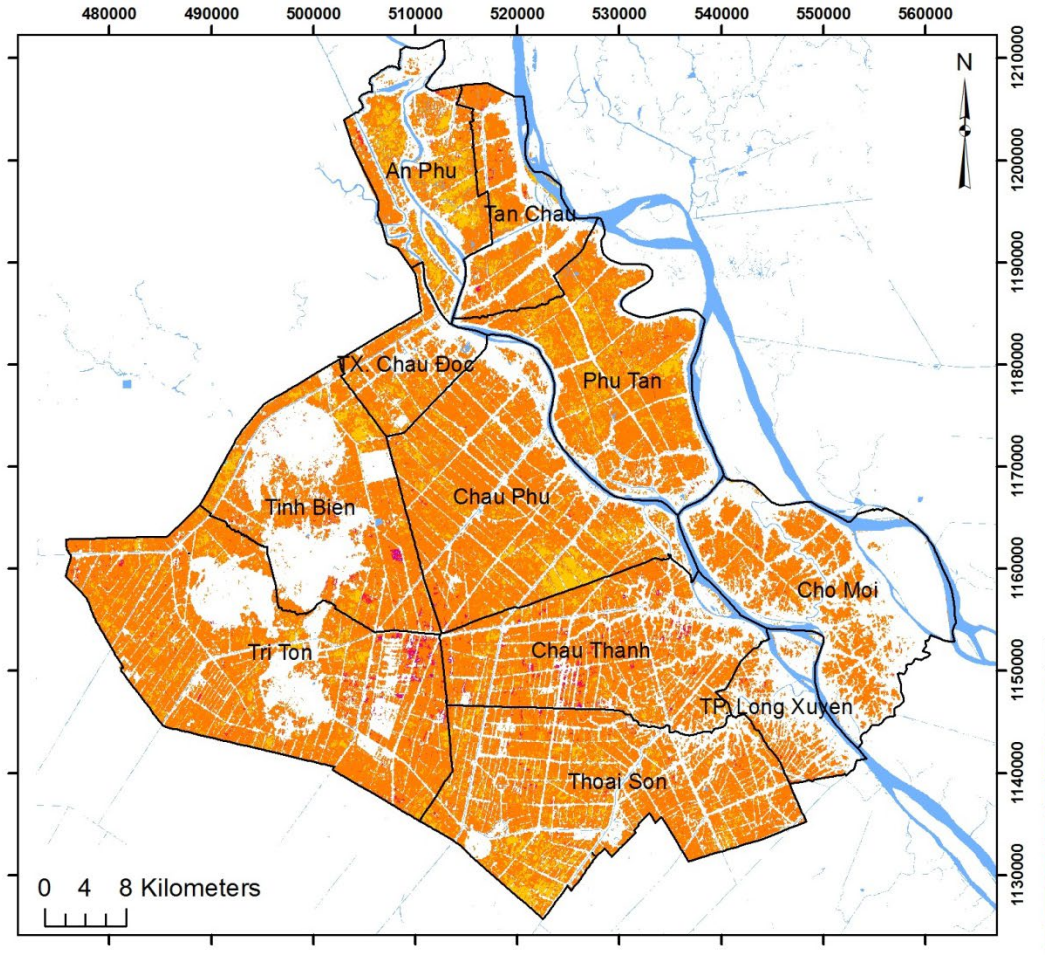




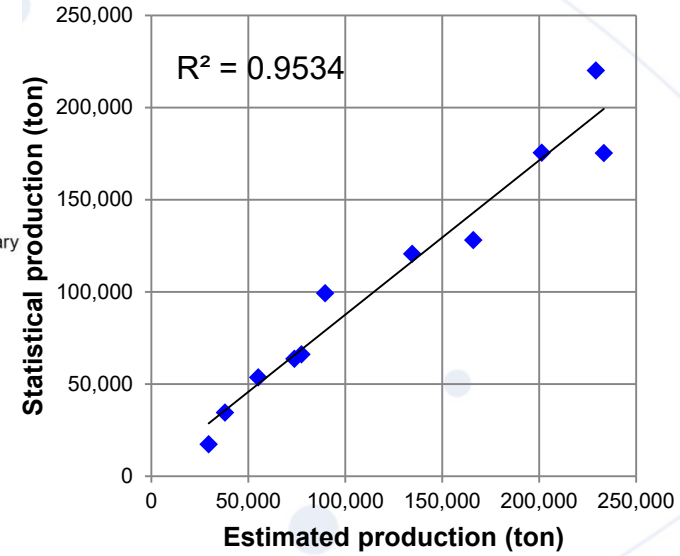
District name	Agency data (ton)	Estimated production (ton)	Percentage error (%)
An Phú	73,656	68,296	-7.3
Chợ Mới	77,296	77,720	0.5
Châu Phú	201,254	166,581	-17.2
Châu Thành	166,054	148,199	-10.8
Phú Tân	134,457	132,012	-1.8
Tịnh Biên	89,584	111,364	24.3
Châu Đốc	37,890	32,798	-13.4
Long Xuyên	29,503	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
Total	**1,325,946**	**1,213,746**	**-8.5**

Data set at provincial scale

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

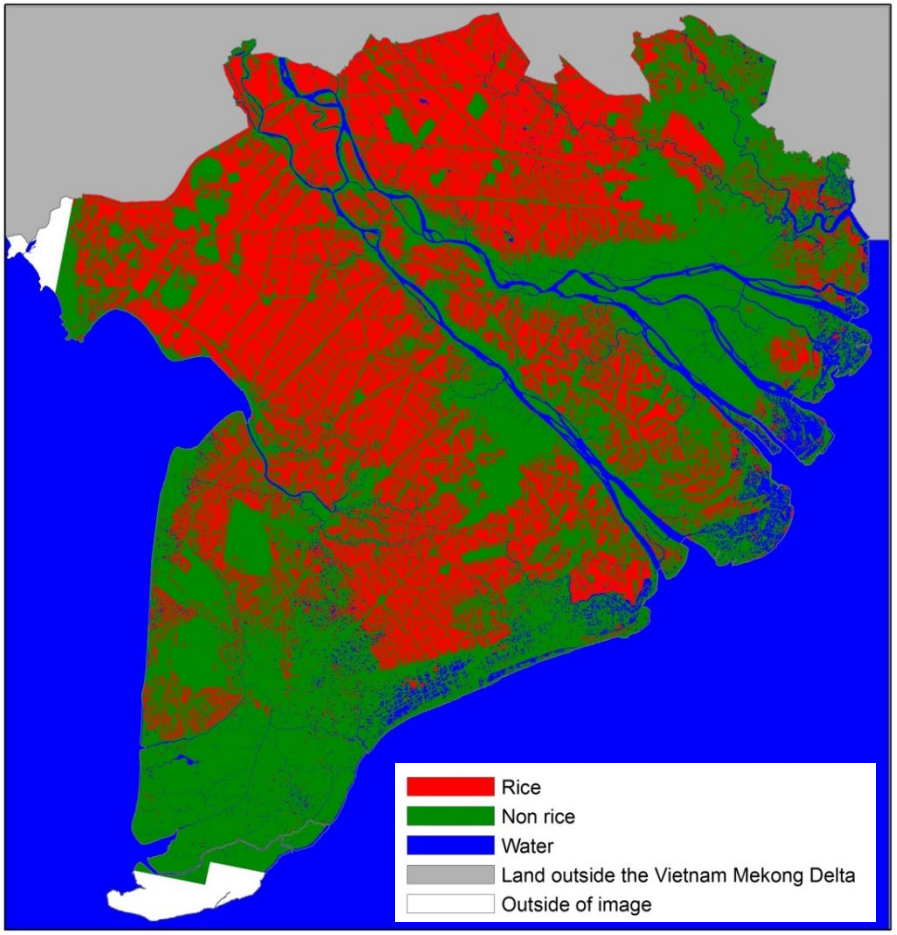


District name	Agency data (ton)	Estimated production (ton)	Percentage error (%)
An Phú	73,656	63,717	-13.5
Chợ Mới	77,296	66,103	-14.5
Châu Phú	201,254	175,556	-12.8
Châu Thành	166,054	128,187	-22.8
Phú Tân	134,457	120,703	-10.2
Tịnh Biên	89,584	99,328	10.9
Châu Đốc	37,890	34,638	-8.6
Long Xuyên	29,503	17,422	-40.9
Thoại Sơn	233,292	175,277	-24.9
Tri Tôn	229,200	220,147	-3.9
Tân Châu	54,994	53,576	-2.6
Total	**1,325,946**	**1,154,655**	**-12.9**

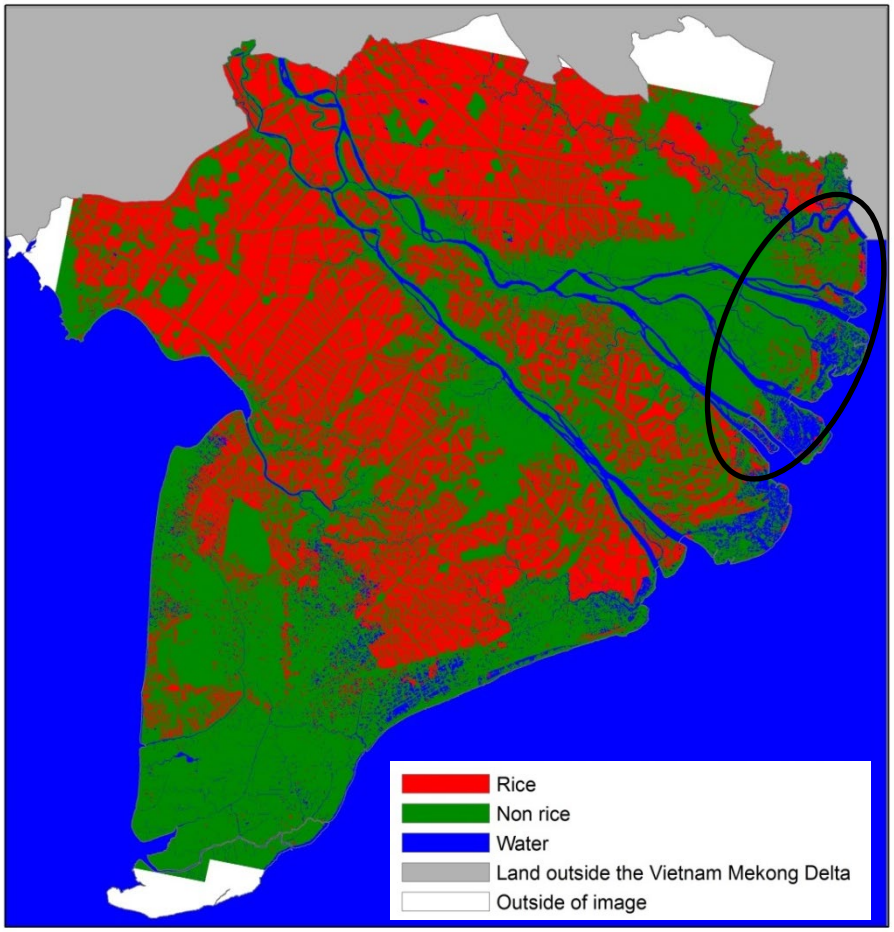


Data set at regional scale

Map of WS Rice 2015



Map of WS Rice 2016



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

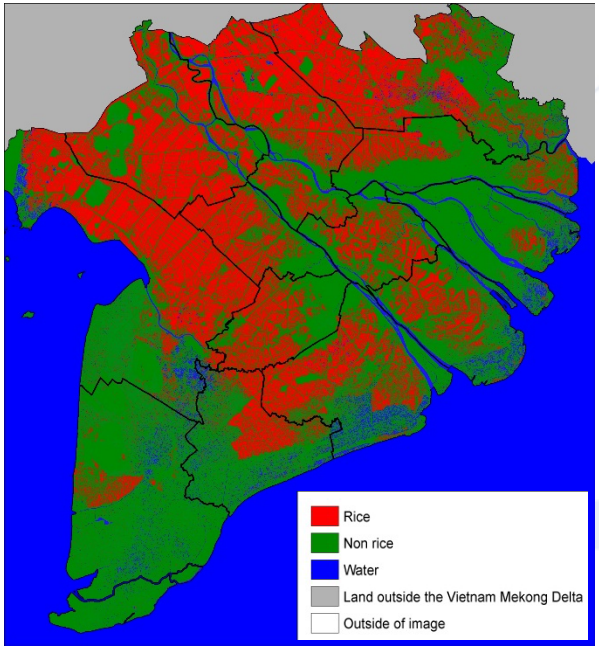
On-going research works – VNRice (2017-)

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** (VNRice)

- ✓ State level research project, 11/2017 - 04/2020 (30 months)
- ✓ RS Data used: SAR data, optical data, fused data
- ✓ Outputs:
  - ❖ Rice planted area maps;
  - ❖ Crop calendars/ crop growth status;
  - ❖ Estimated yield & production.

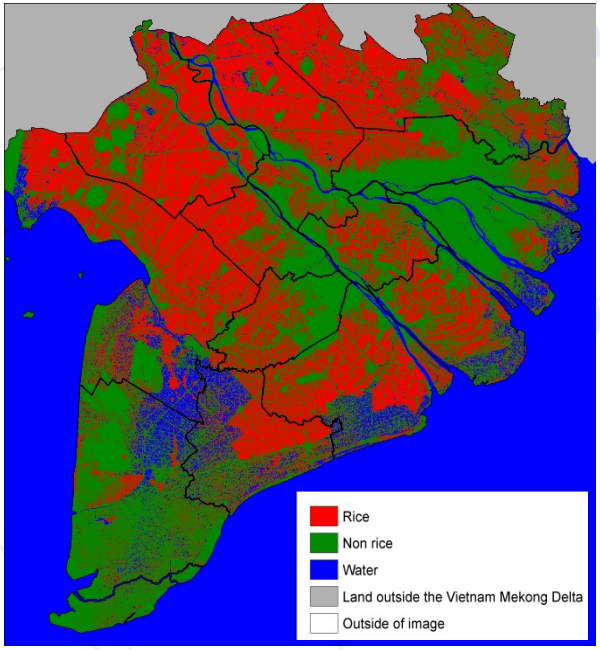
VNRice (2017-): Rice/Non-rice maps

Map of WS Rice 2018



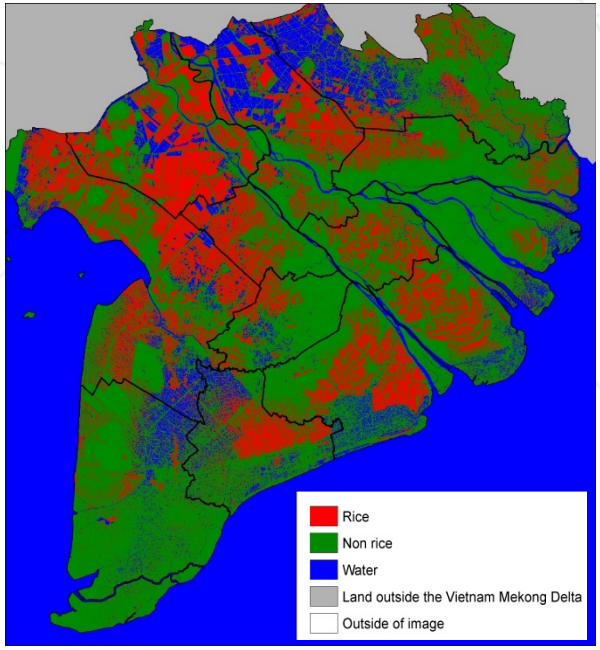
Acc.: 93.4%

Map of SA Rice 2018



Acc.: 91.7%

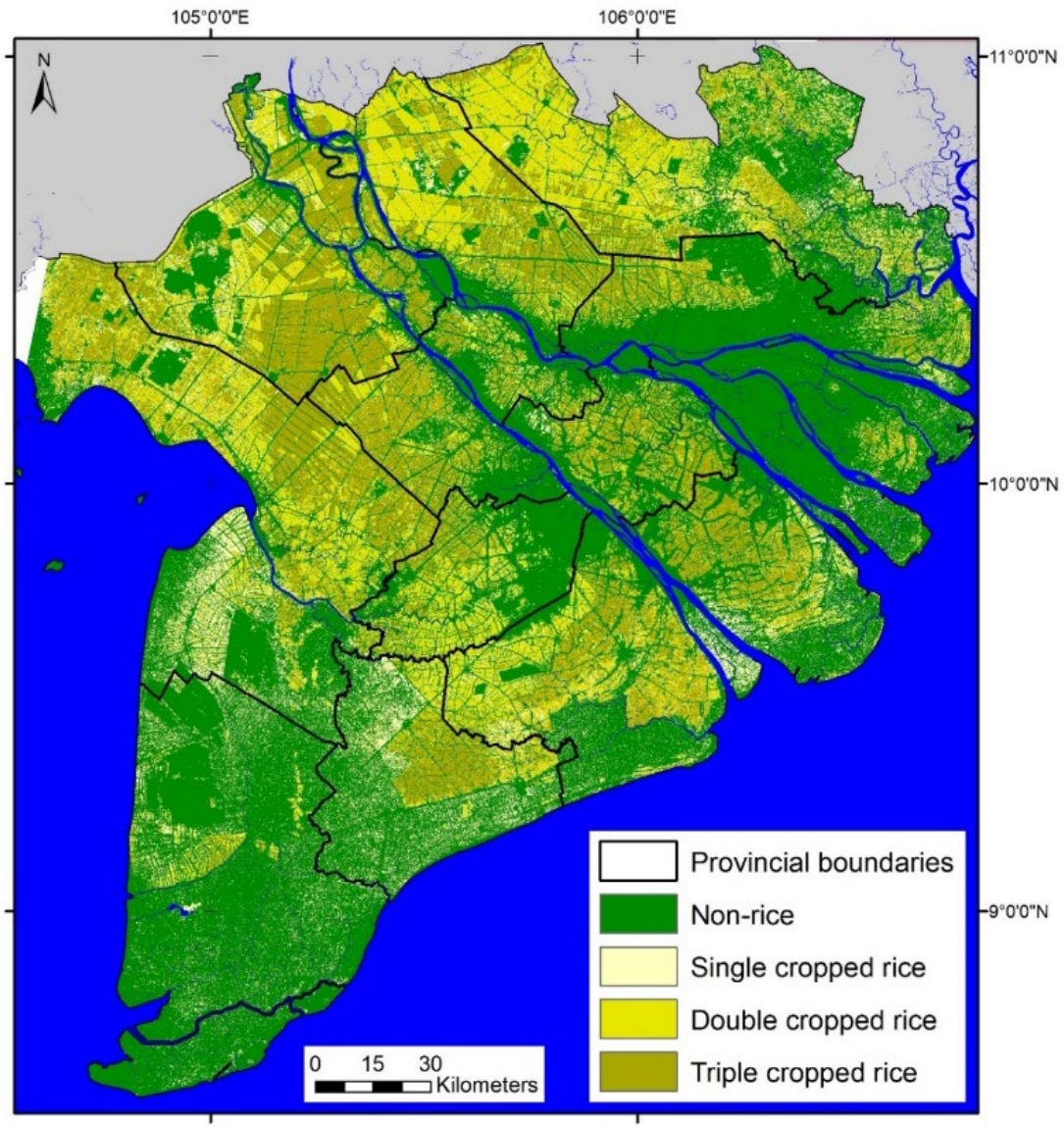
Map of AW Rice 2018



Acc.: 92.4%

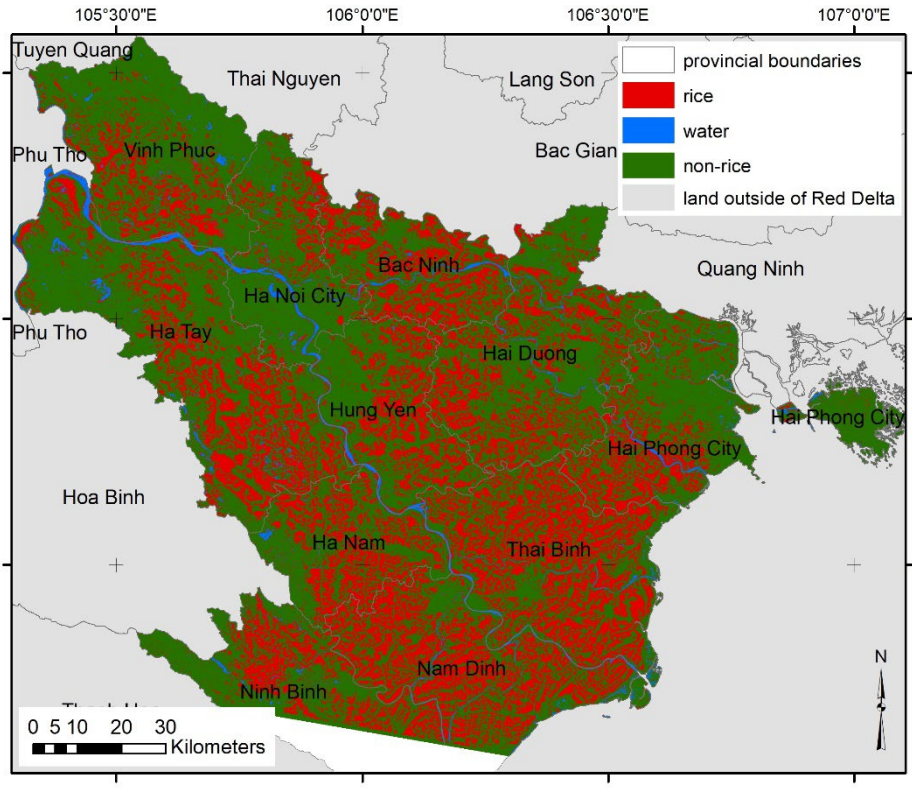
Rice crop maps in the Mekong Delta, Vietnam

VNRice (2017-): Rice/Non-rice maps

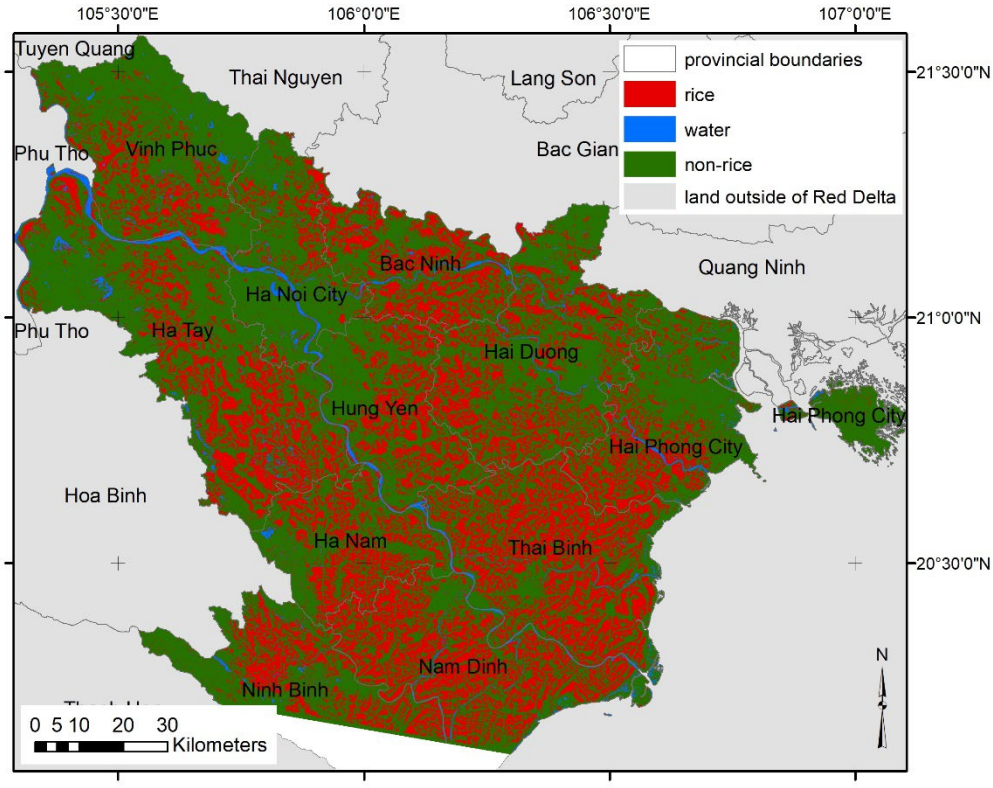


Combination of 3 rice crop maps → Rice cropping system map in the MD

VNRice (2017-): Rice/Non-rice maps



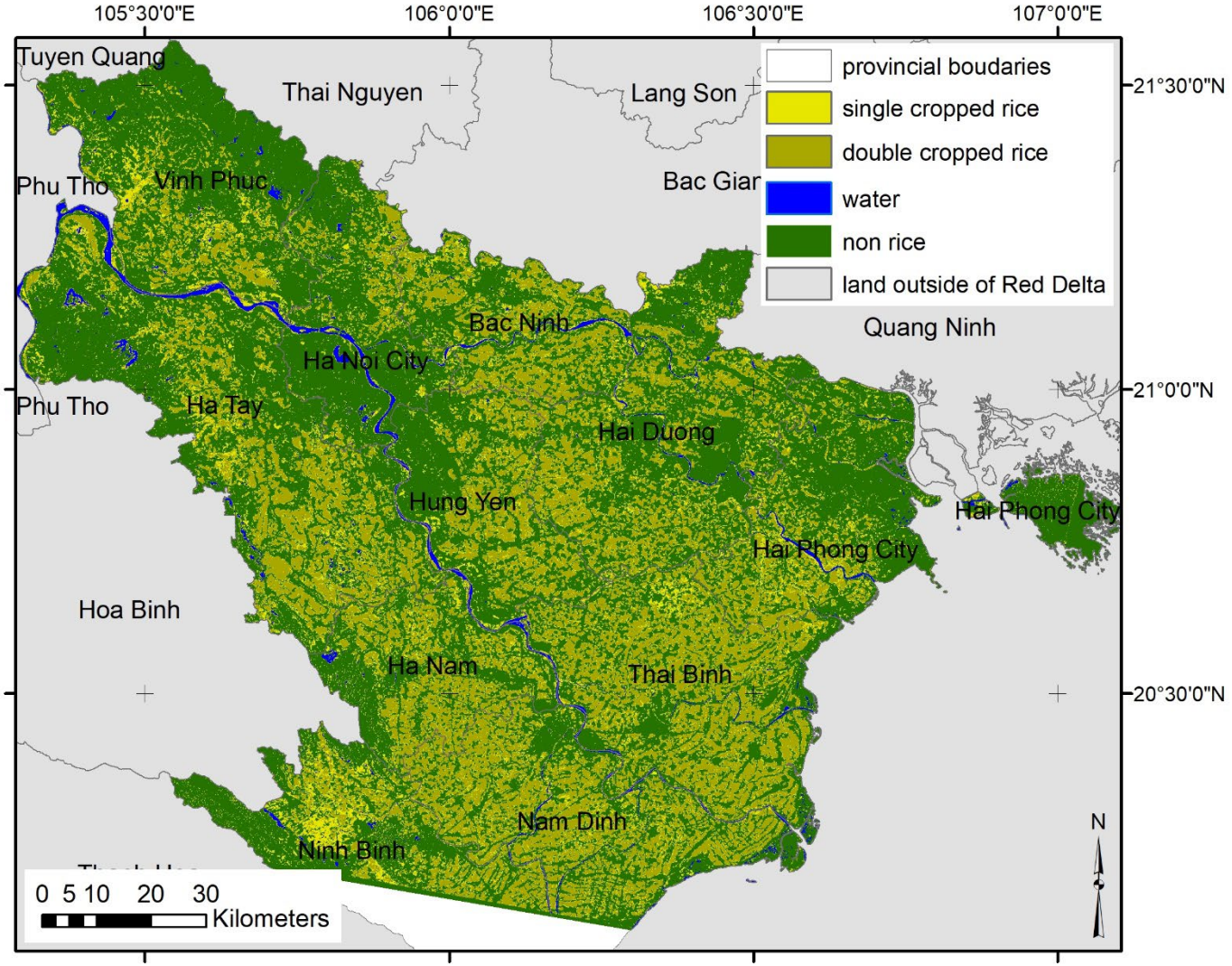
Map of WS Rice 2018



Map of Autumn (Mua) Rice 2018

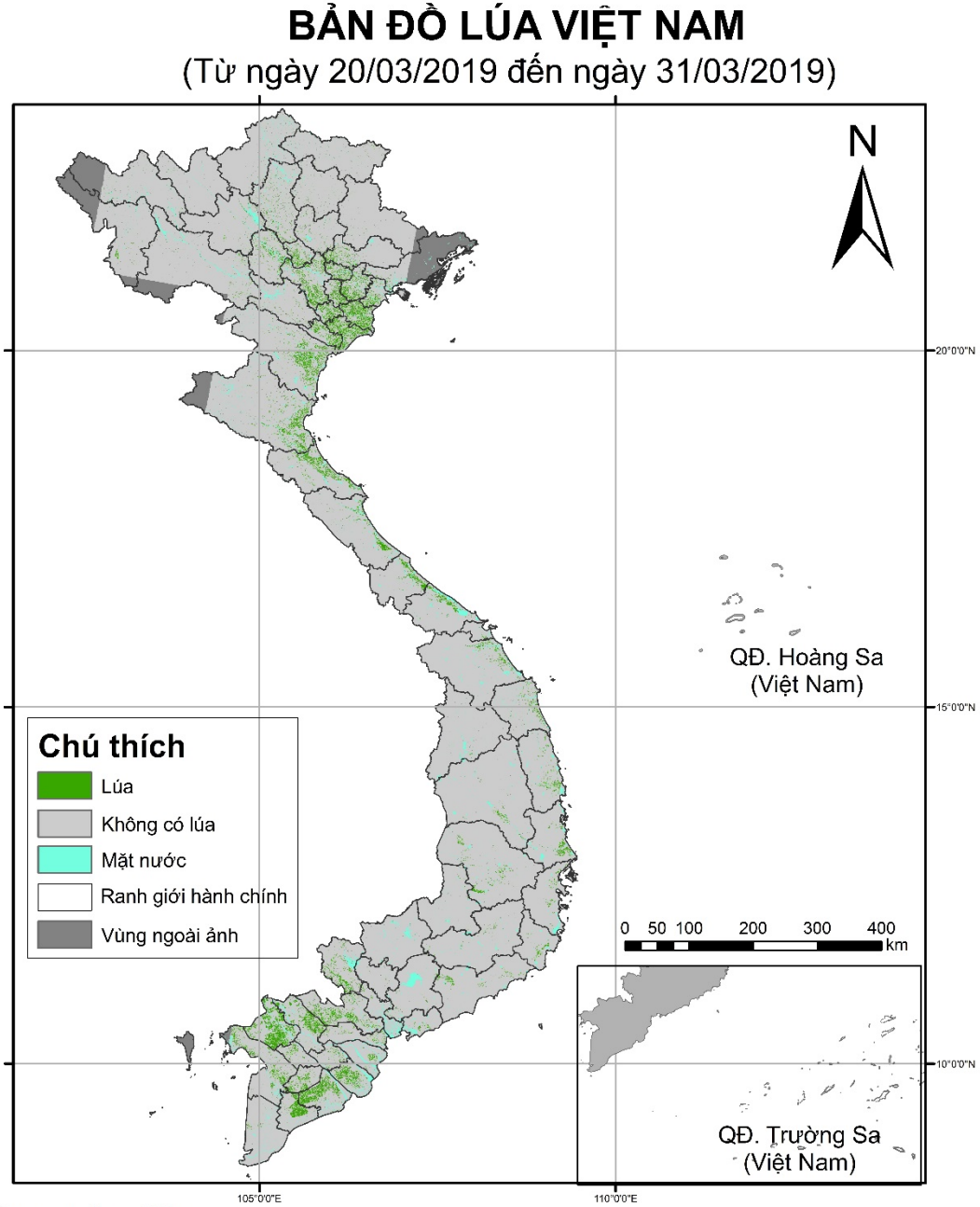
Rice crop maps in the Red River Delta, Vietnam

VNRice (2017-): Rice/Non-rice maps



Combination of 2 rice crop maps → Rice cropping system map in RRD

e maps



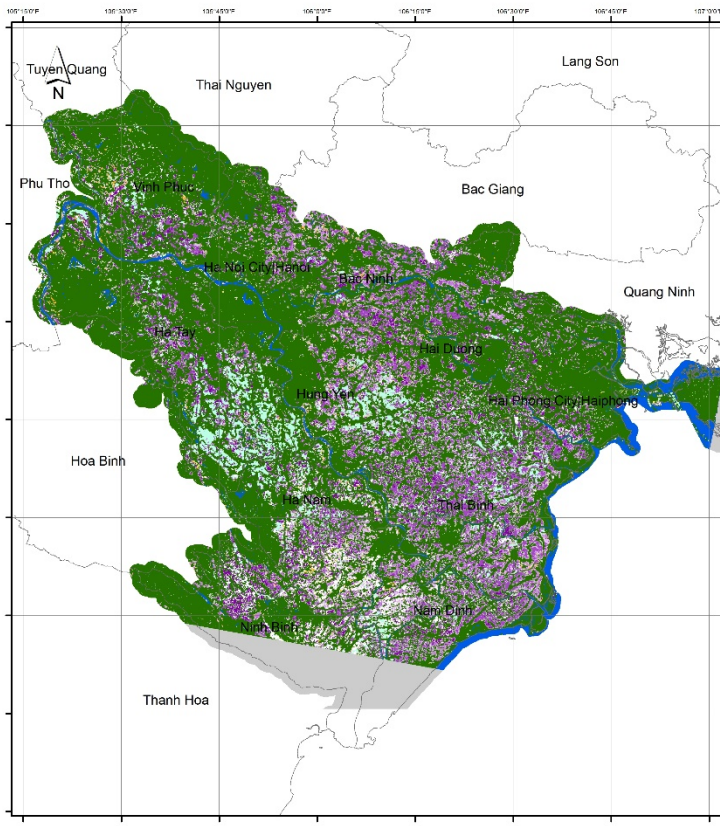
Cơ quan thực hiện:
Trung tâm Ứng dụng Công nghệ Vũ trụ TP. Hồ Chí Minh (STAC)
Trung tâm Vũ trụ Việt Nam (VNSC)
Viện Hàn lâm Khoa học và Công nghệ Việt Nam (VAST)

Rice / Non-rice map of Vietnam in March 2019

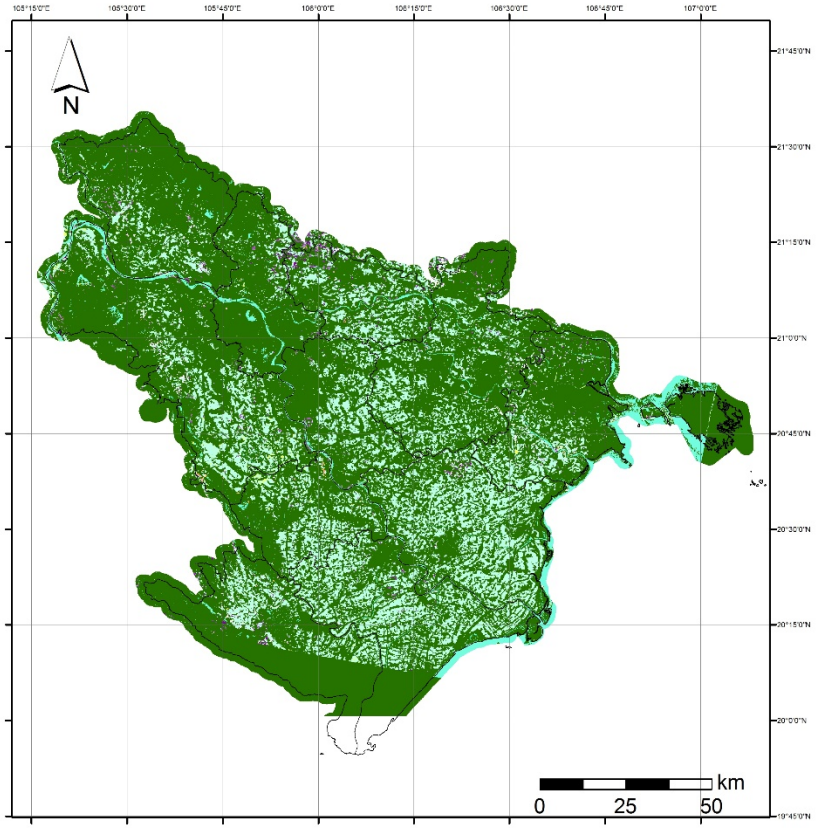
VNRice (2017-): Days after sowing

June 16, 2018

July 10, 2018



Ho Chi Minh City Space Technology Application Center (STAC)
Vietnam National Space Center (VNSC)
Vietnam Academy of Science and Technology (VAST)
Address: 268A Nam Ky Khoi Nghia St., Dist. 3, Ho Chi Minh City, Vietnam



Bản đồ ngày s
(10/07/201

Ngày sau khi sạ/cấy

- Không phải lúa
- Mặt nước
- Đất lúa sau thu hoạch
- 01 - 10 ngày
- 11 - 20 ngày
- 21 - 30 ngày
- 31 - 40 ngày
- 41 - 50 ngày
- 51 - 60 ngày
- 61 -70 ngày
- 71 - 80 ngày
- 81 - 90 ngày
- 91 - 100 ngày
- 101 - 110 ngày
- 111 - 120 ngày
- Ranh giới hành chính tỉnh

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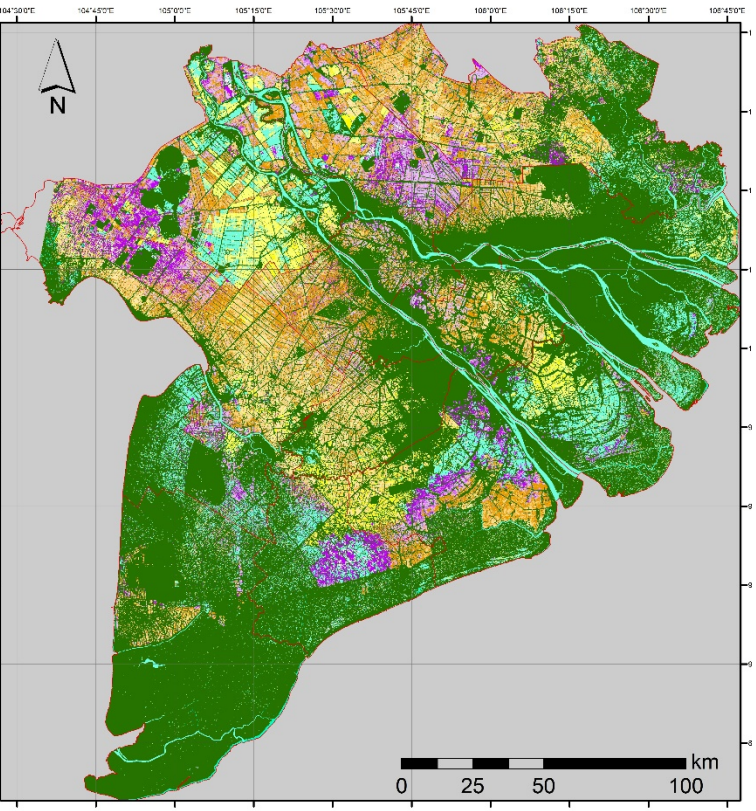
Viện Hàn lâm Khoa học và Công nghệ Việt Nam (VAST)

Map of rice age in the Red River Delta

VNRice (2017-): Days after sowing

Jan. 13, 2019



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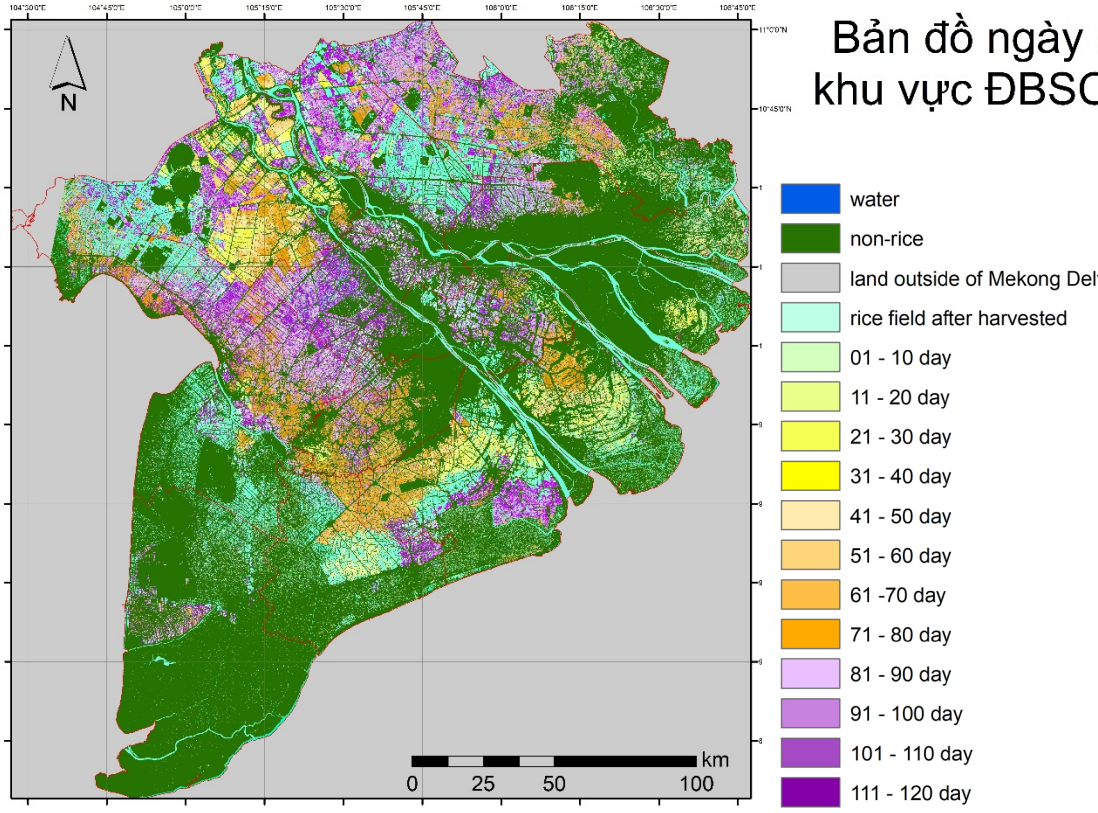
Feb. 12, 2019



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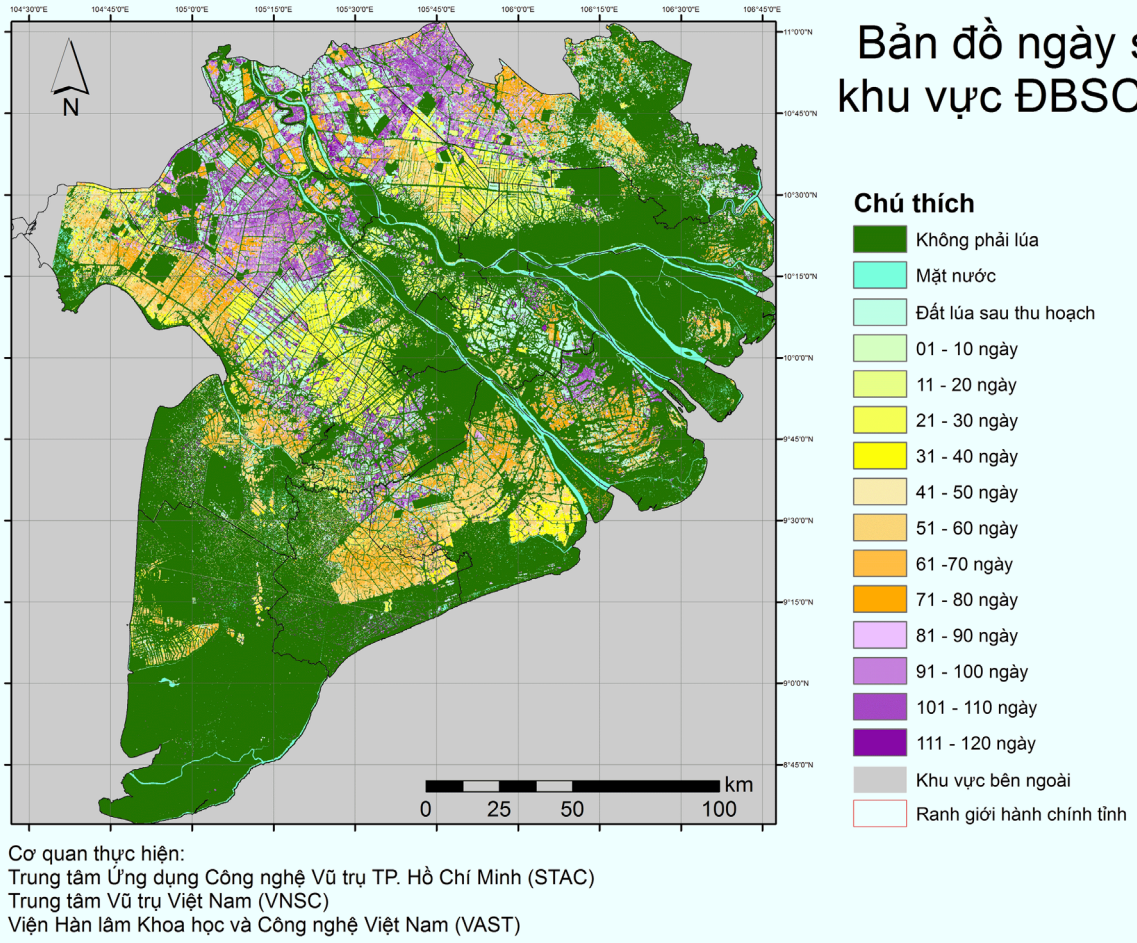
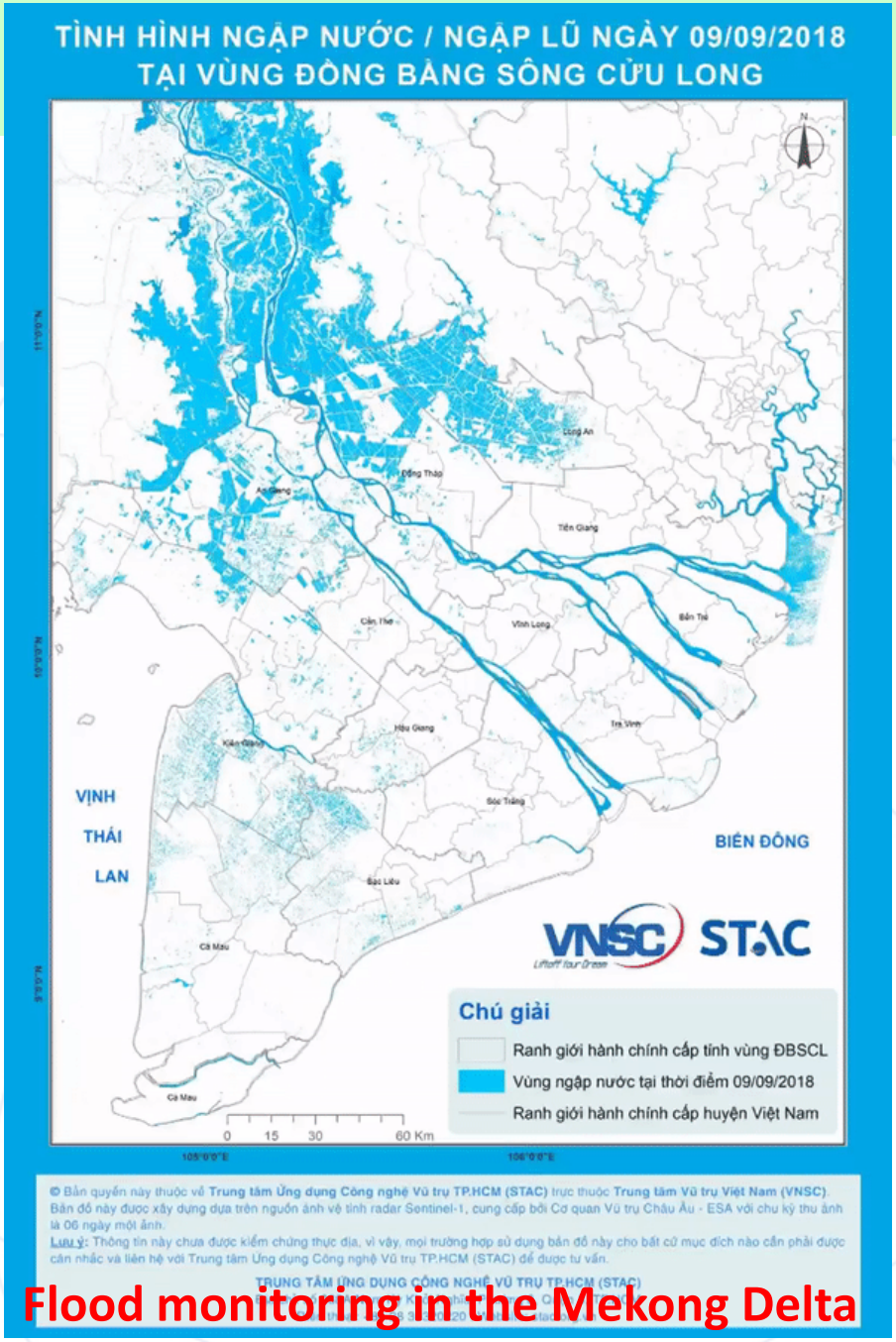
Map of rice age in WS 2019 crop in the Mekong Delta

VNRice (2017-): Days after sowing

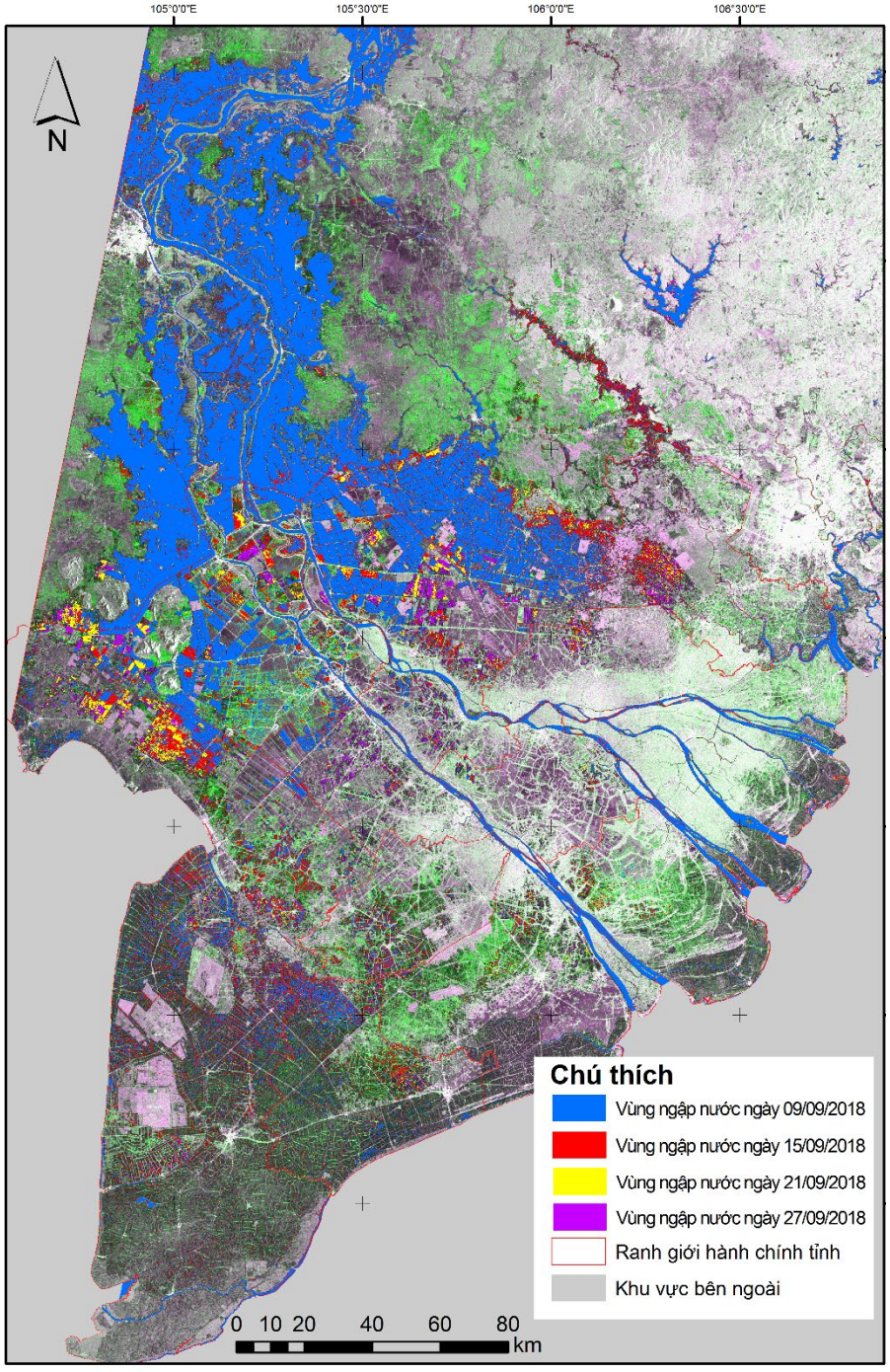


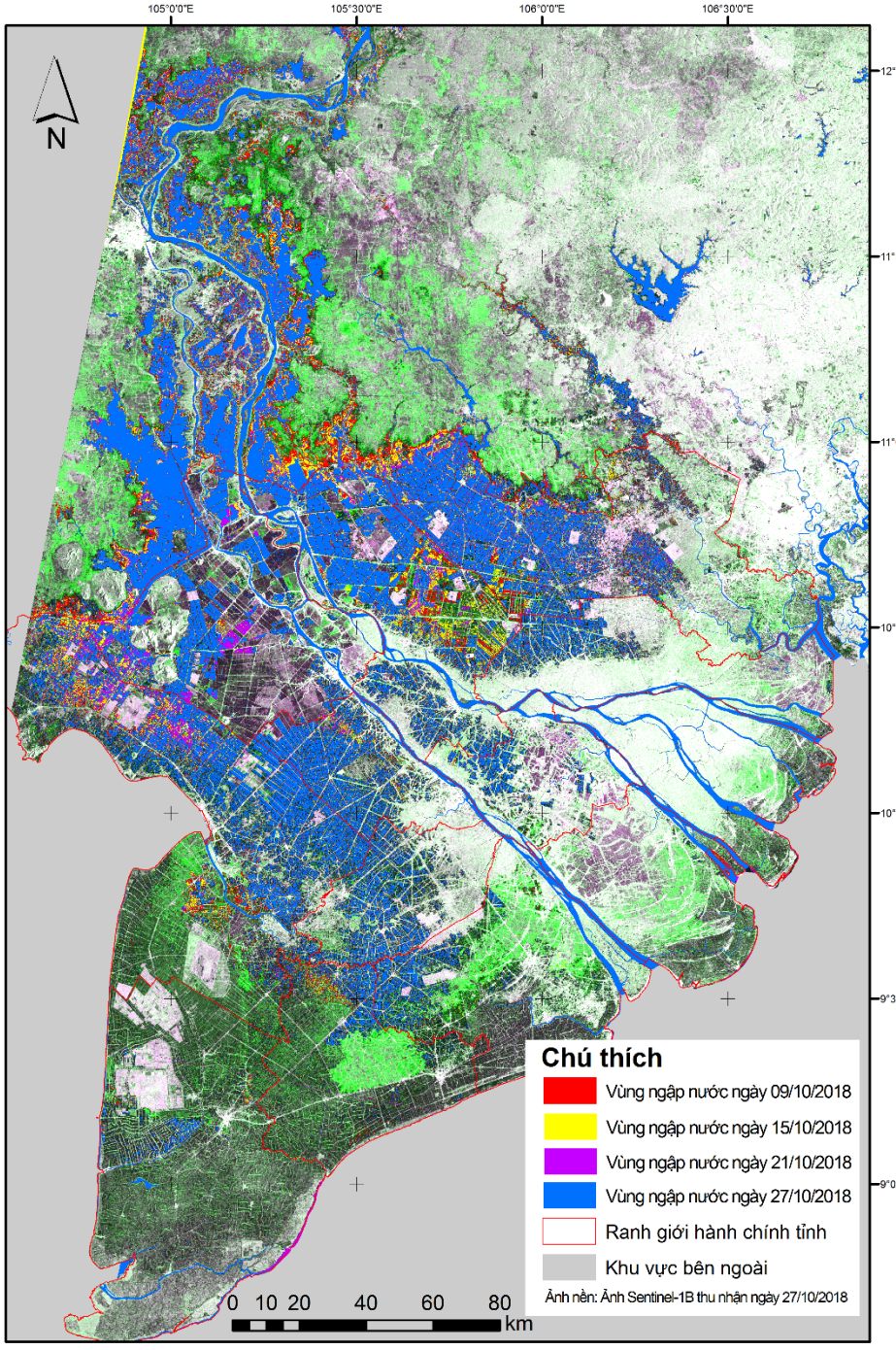
Days after rice sowing/transplanting in the Mekong Delta (Aug. 2018 – May 2019)

Flood monitoring



Flood monitoring in the Mekong Delta


105°0'0"E
105°30'0"E
106°0'0"E
106°30'0"E
N
Chú thích
Vùng ngập nước ngày 09/09/2018
Vùng ngập nước ngày 15/09/2018
Vùng ngập nước ngày 21/09/2018
Vùng ngập nước ngày 27/09/2018
Ranh giới hành chính tỉnh
Khu vực bên ngoài
0 10 20 40 60 80
km


105°0'0"E
105°30'0"E
106°0'0"E
106°30'0"E
N
12°
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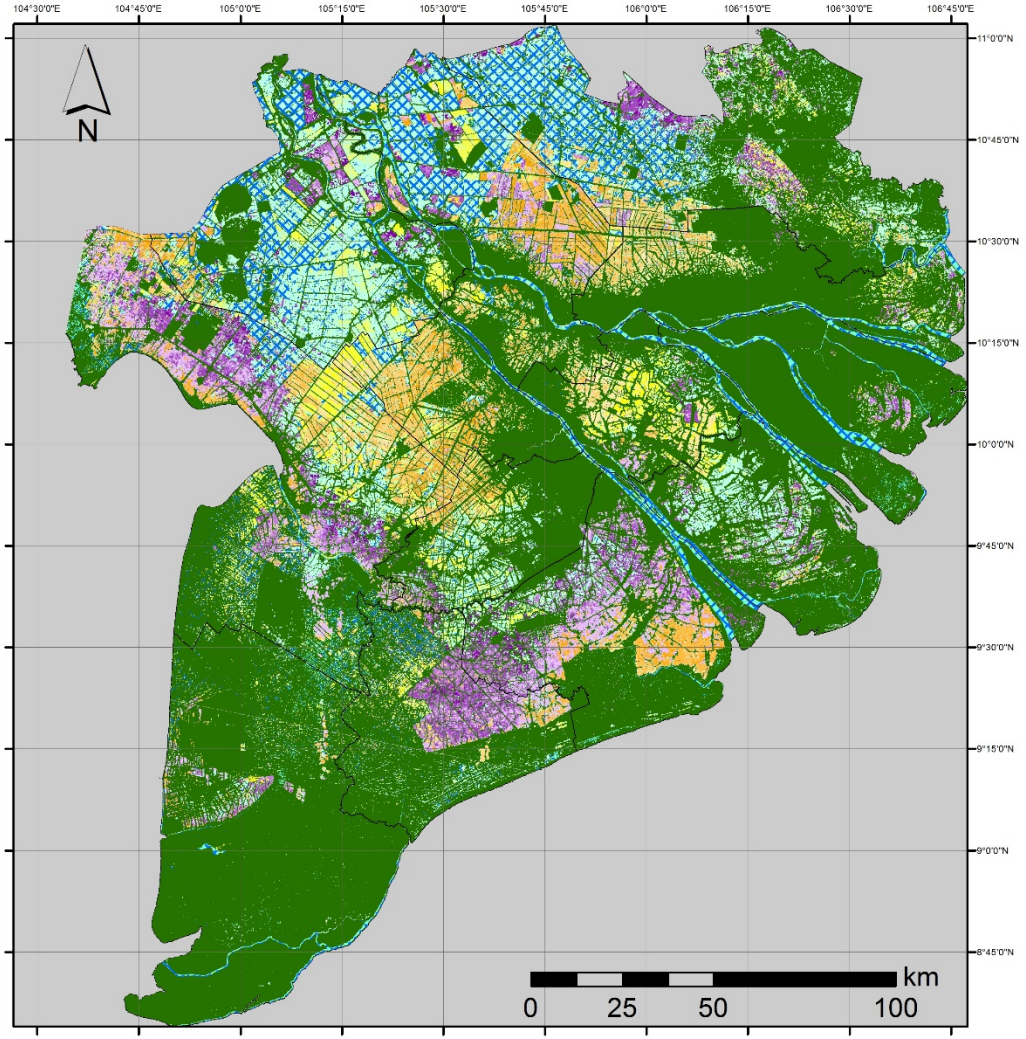
10°
10°
9°3
9°0
Chú thích
Vùng ngập nước ngày 09/10/2018
Vùng ngập nước ngày 15/10/2018
Vùng ngập nước ngày 21/10/2018
Vùng ngập nước ngày 27/10/2018
Ranh giới hành chính tỉnh
Khu vực bên ngoài
Ảnh nền: Ảnh Sentinel-1B thu nhận ngày 27/10/2018
0 10 20 40 60 80
km



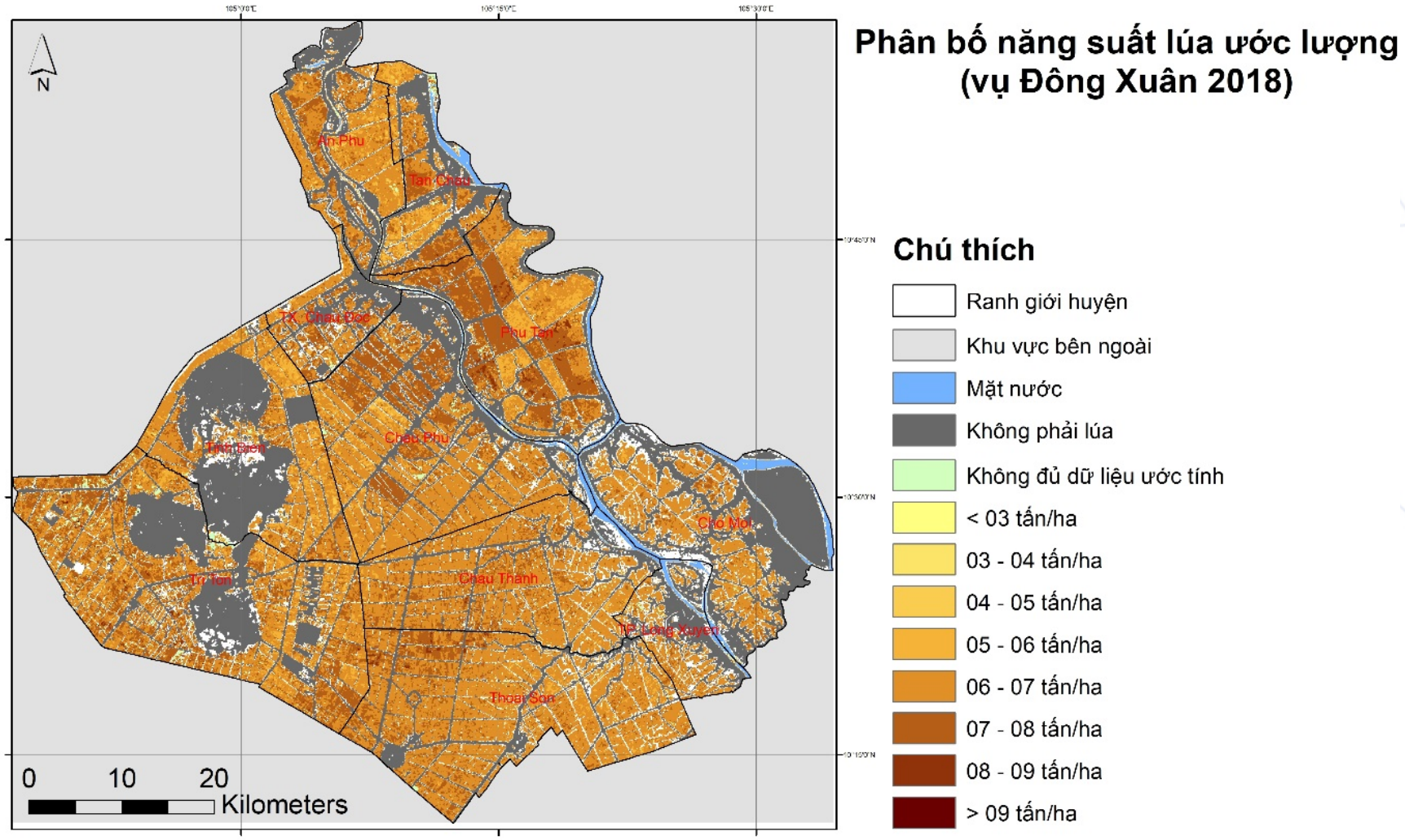
Bản đồ ngày sau khi sạ/cấy khu vực ĐBSCL (09/09/2018)

Chú thích

- Không phải lúa
- Mặt nước
- Vùng ngập nước
- Đất lúa sau thu hoạch
- 01 - 10 ngày
- 11 - 20 ngày
- 21 - 30 ngày
- 31 - 40 ngày
- 41 - 50 ngày
- 51 - 60 ngày
- 61 -70 ngày
- 71 - 80 ngày
- 81 - 90 ngày
- 91 - 100 ngày
- 101 - 110 ngày
- 111 - 120 ngày
- Khu vực bên ngoài
- Ranh giới hành chính tỉnh

Cơ quan thực hiện:
Trung tâm Ứng dụng Công nghệ Vũ trụ TP. Hồ Chí Minh (STAC)
Trung tâm Vũ trụ Việt Nam (VNSC)
Viện Hàn lâm Khoa học và Công nghệ Việt Nam (VAST)

VNRice (2017-): Rice yield maps



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A distribution map of estimated rice yield of WS 2018 in An Giang

Vietnam Data Cube (2017-)

- Infrastructure: by help of IMSG (I. M. Systems Group, Inc.)
- Software:
  - Supports from CSIRO&CEOS
- Satellite Data:
  - Landsat from USGS
  - ALOS from JAXA
  - Sentinel-1&-2 from ESA
- Priority applications:
  - Forest monitoring
  - **Rice monitoring**
  - Water monitoring.

Vietnam Data Cube

Vietnam Open Data Cube | Home | Data Cube Manager | Tools | Task Manager | Submit Feedback | Log In

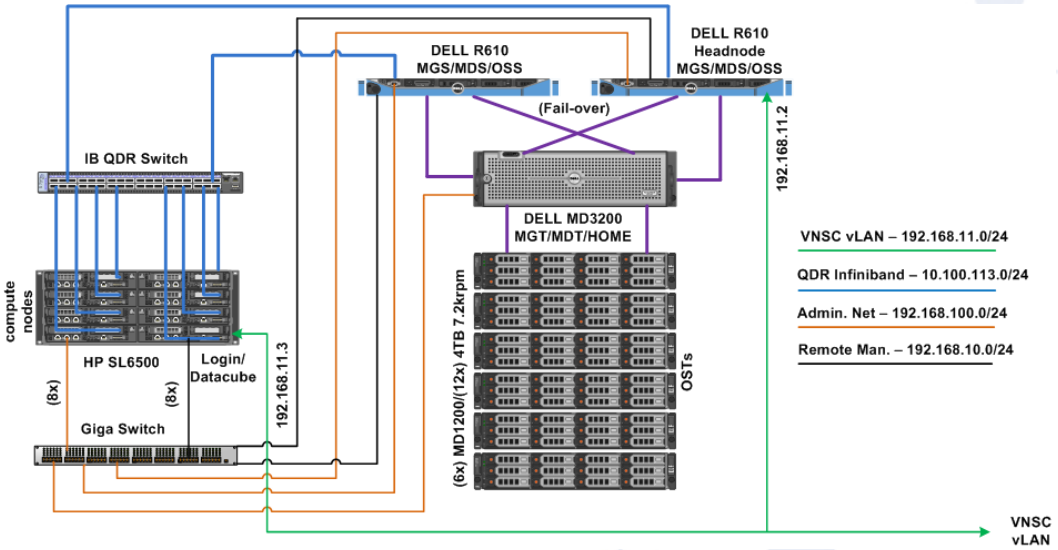
Welcome to the Vietnam Open Data Cube

Vietnam National Space Center is using the power of the Open Data Cube to help address the needs of satellite data users, giving them a better picture of their land resources and land change.

- Ease of use and access to satellite-based data
- Multiple dataset interoperability and spatial consistency
- Use of "Analysis Ready" Data Products
- A Shift in Paradigm from Scenes to Pixels

Log In

Vietnam Data Cube



1 head node, 1 login node, 7 compute nodes (each: 16 core 2.2GHz, 64GB RAM), 40Gb/s Infiniband Interconnect network
Full redundant parallel storage – LustreFS: 195TB, max read/write speed: 1.9GB/s
Total storage capacity (including work, home, local): ~ 220TB
Can be expanded to hundreds of compute nodes, hundreds of TBs of storage

2019 CEOS Chair Initiatives

VNSC CEOS Chair 2019

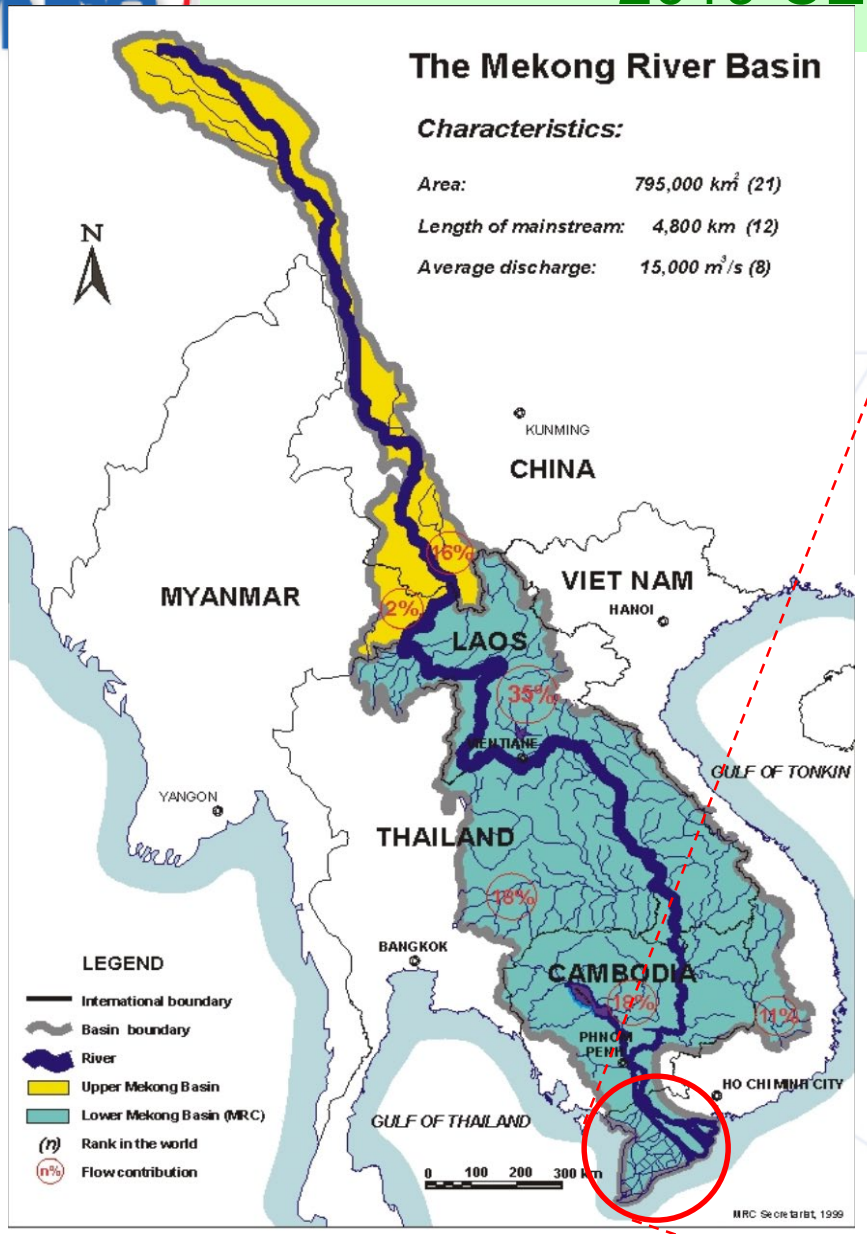
- Application Focused Initiatives
  - Carbon Observations (forested regions)
  - Observations for Agriculture (rice)

- Regional Observatory can be built with ready application built-in such as forest monitoring and rice monitoring for Mekong river area.

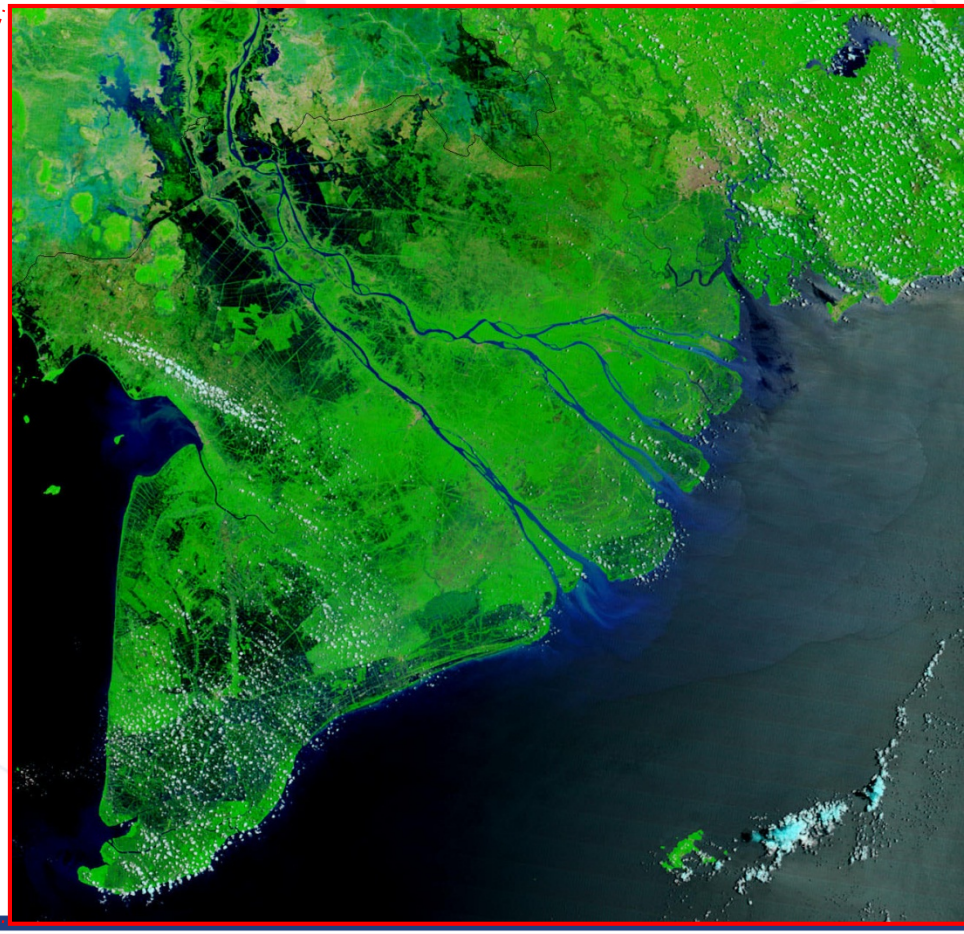
- Rice monitoring initiative:
  - VNSC/STAC: VNRice project
  - CNES/CESBIO: GEORice project
  - JAXA&RESTEC

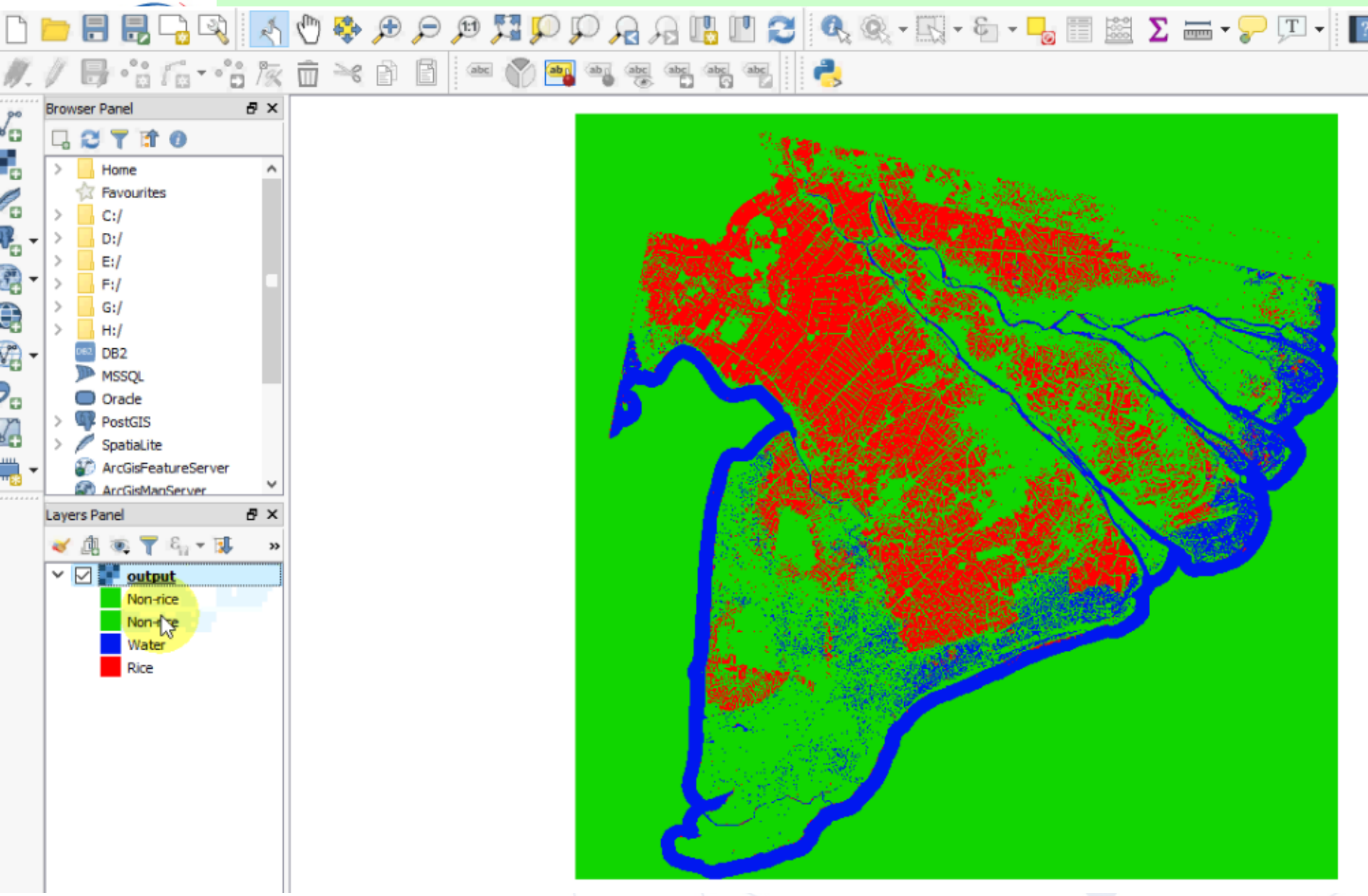
  → Cross validation of the results made by 3 teams.

2019 CEOS Chair Initiatives



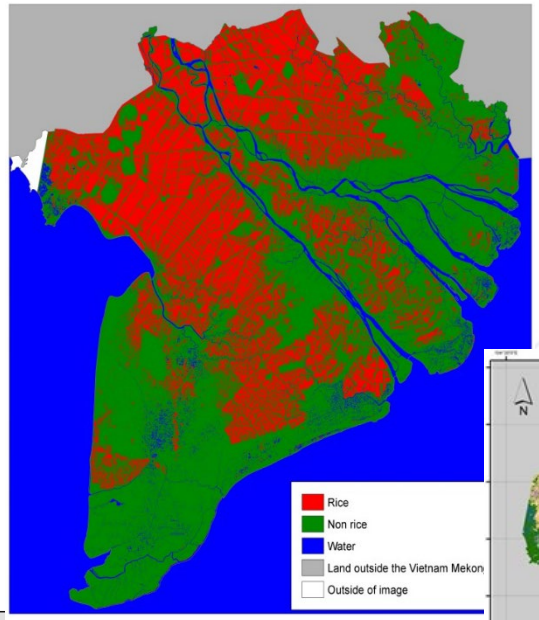
Mekong basin

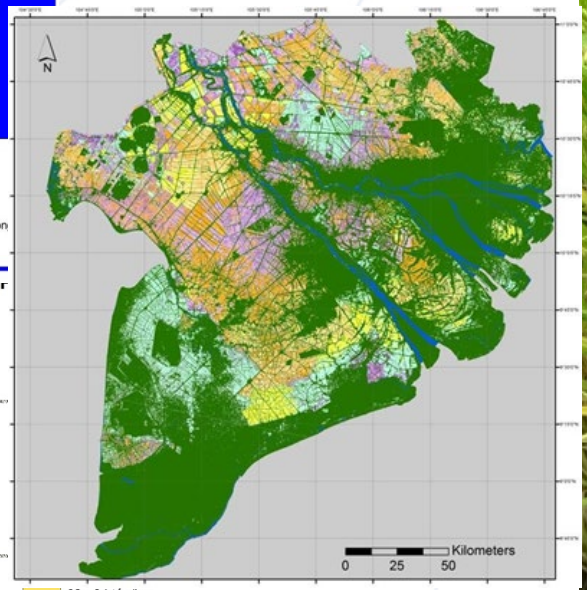


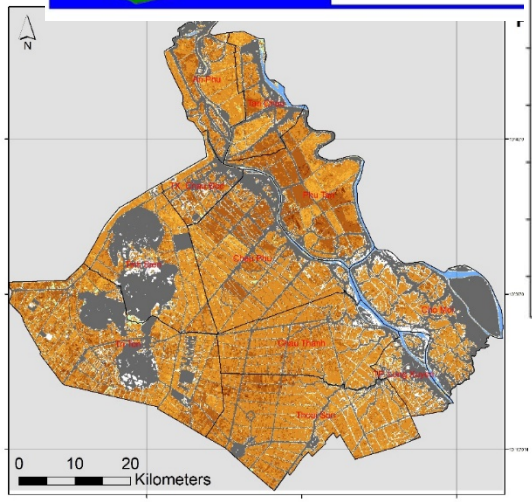


Classified image

Towards a National crop monitor







03 - 04 tấn/ha
04 - 05 tấn/ha
05 - 06 tấn/ha
06 - 07 tấn/ha
07 - 08 tấn/ha
08 - 09 tấn/ha
> 09 tấn/ha

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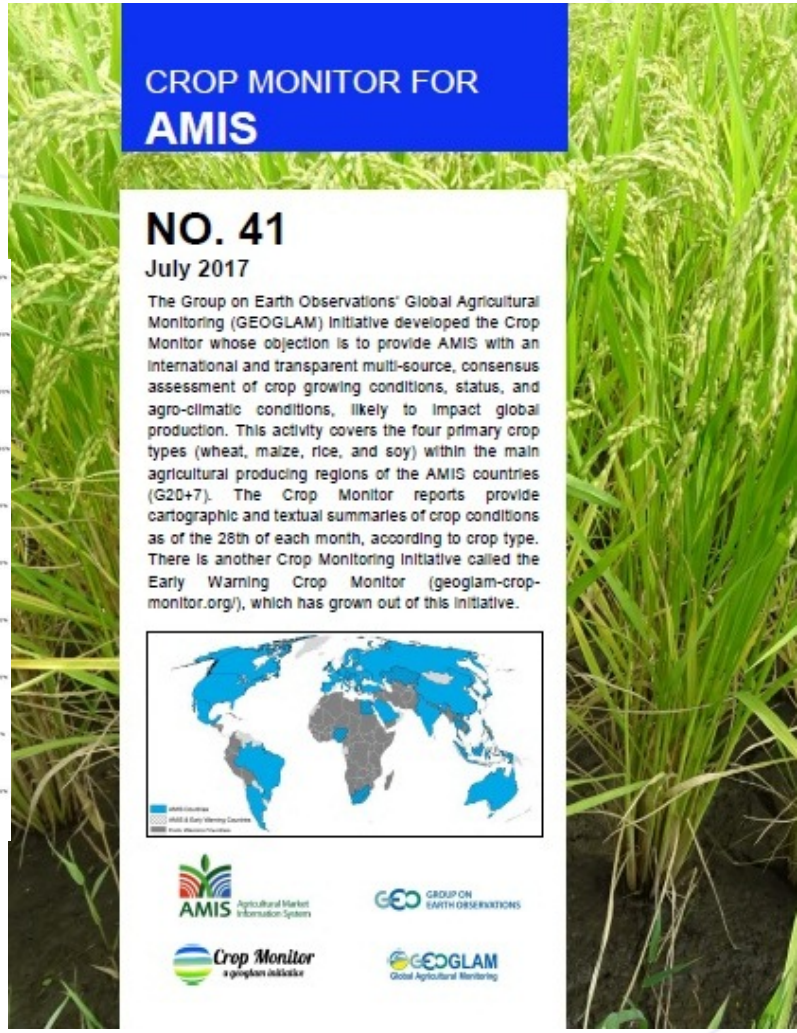
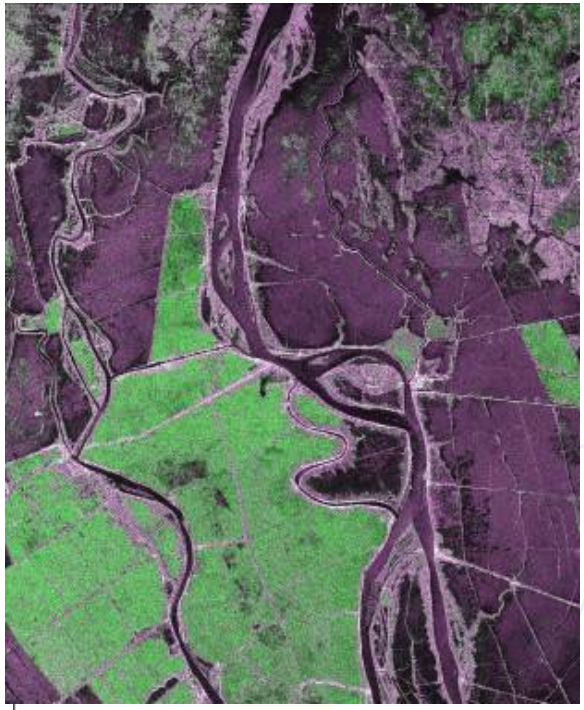


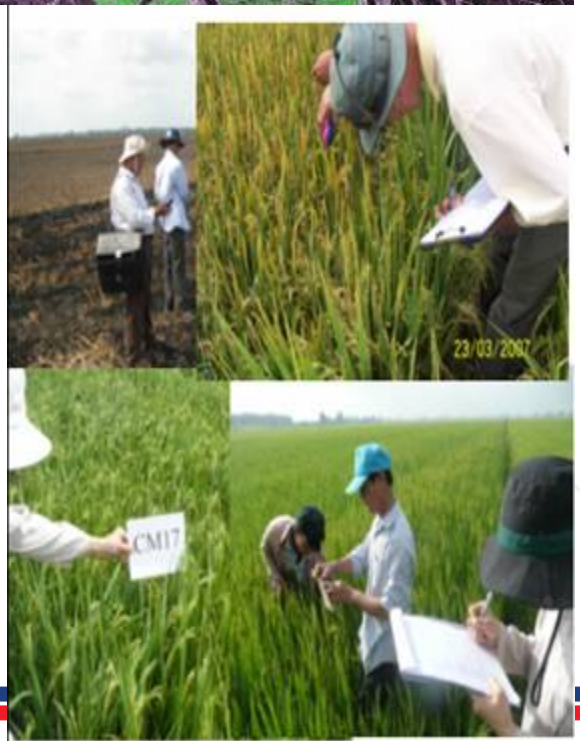
Conclusions

- Previous studies have proven **remote sensing is an efficient tool for rice monitoring using various SAR data**, ENVISAT-ASAR, TerraSAR-X, COSMO-SkyMed, RADARSAT-2, ALOS-2, Sentinel-1.

- On-going research projects have been doing for rice monitoring to **validate the method at regional and national scale.**

- **Rice monitoring initiative is focused on Mekong region in international collaboration** with CNES/CESBIO (GEORice project) and JAXA&RESTEC and its results will be validated and presented at the 2019 CEOS plenary.





Thank you

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Email: ldnguyen@vnsc.org.vn