Rice Monitoring from Space ?

Thuy Le Toan
CESBIO, Toulouse, France

The GEORICE Project

Towards Operational Rice Monitoring

Thuy Le Toan, Phan Thi Hoa
Alexandre Bouvet

Benjamin Koetz

Lam Dao Nguyen, VNSC

Sandrine Daniel

Asia-RiCE Crop Estimation and Monitoring

GEOGLAM Global Agricultural Monitoring

Importance of rice monitoring in SE Asia

- Rice is the staple food for more than half of humanity - with 90% of the world crop grown and consumed in Asia. .
- The high population growth rate in Asia together with the approaching limits of land use and enhanced climate change, are impacting:

  - food security, tensions in rice markets
  - water resources
  - GHG, biodiversity, forest conservation…

→ Accurate and timely information is needed for rice monitoring, and satellite remote sensing can meet requirements at local to global scales

→ The Asia-Rice/GEOGLAM initiative

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EO for rice monitoring

- Among EO data, SAR data have been proved efficient for rice monitoring since late 80's , but applications have been hampered by lack of systematic and cost effective data

- Sentinel-1 represents unpreceding opportunity for operational rice monitoring applications

- R&D Demonstrator projects were urgently needed with the launch of Sentinel-1 in April 2014

The GEORICE project

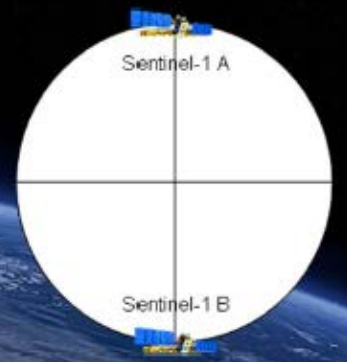
GEORICE: Towards Global Earth Observation of Rice

ESA Contract No. 4000113388/15/I-NB

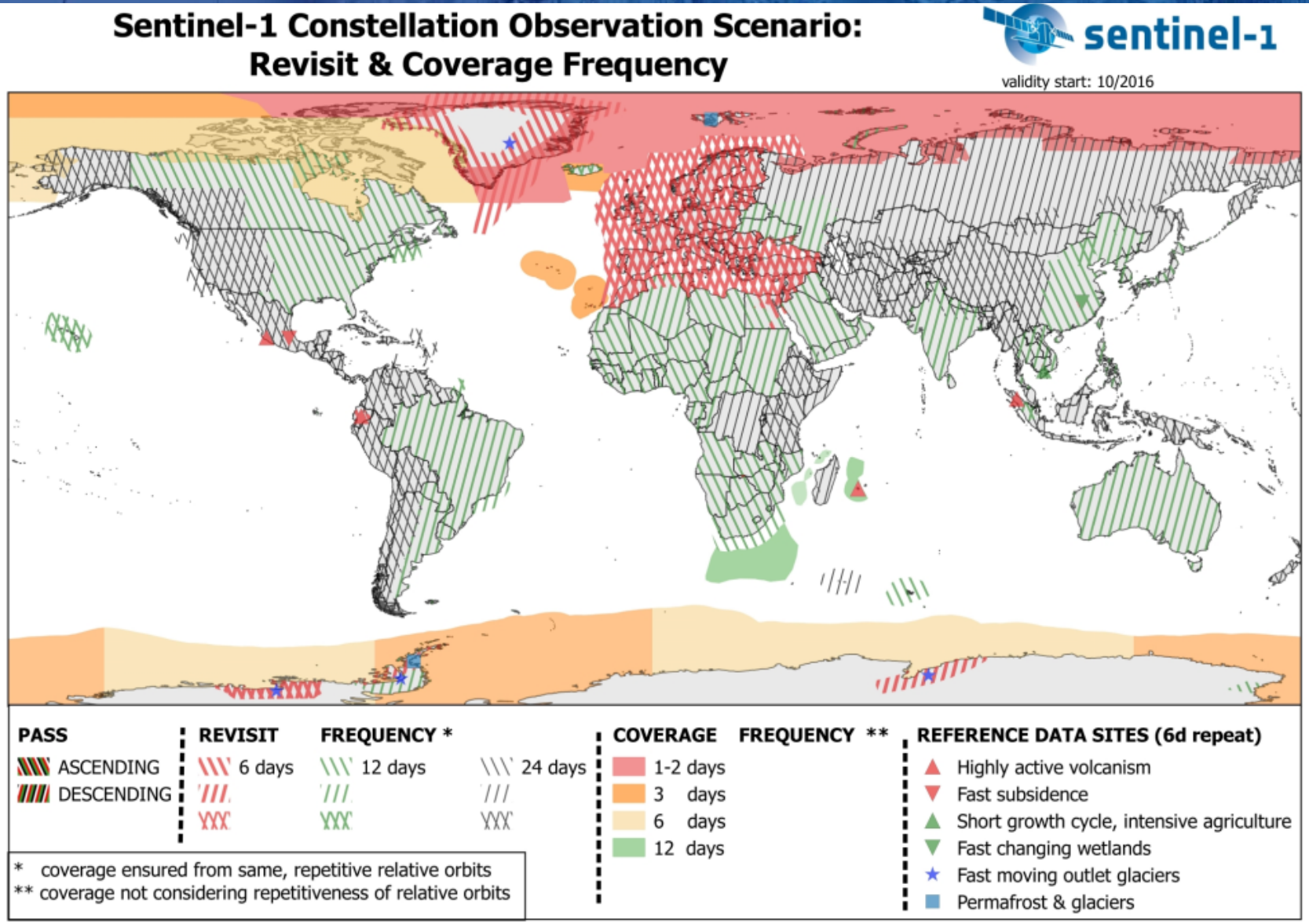
Programme	**Data User Elements (DUE)**
Type	Service Demonstrator
Duration	1 March 2015-1 March 2017
Prime Contractor	Université PaulSabatier/CESBIO
Subcontractor	Capgemini, France
Collaborators	VN Satellite Technology and Applications; The Univ. An Giang
Target Users	GEOGLAM/Asia-RICE Ministry of Agriculture and Rural Developt, VN
Project Manager	Thuy Le Toan, CESBIO
ESA POC	Benjamin Koetz

Sentinel-1: Mission Profile

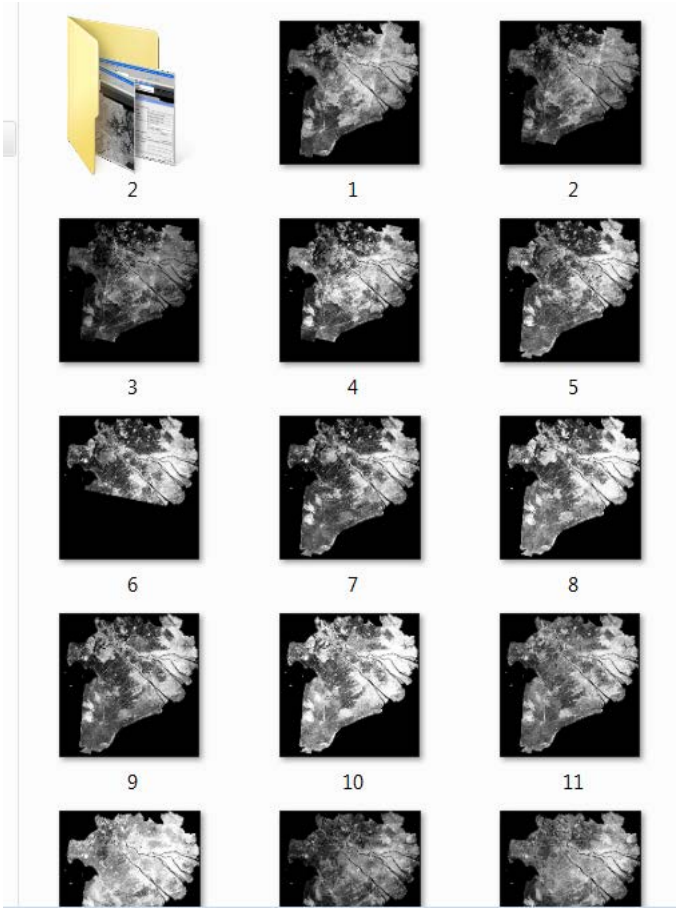
- Mission based on 2 satellites
- C-band Radar instrument
- Sun-synchronous orbit at 693 km altitude
- Inclination: 98.18°
- 7 years lifetime
- Consumables for 12 years
- Mean LST: 18:00h at ascending node
- 12-day repeat cycle at Equator (6 days with 2 satellites)
- 96h operative onboard autonomy

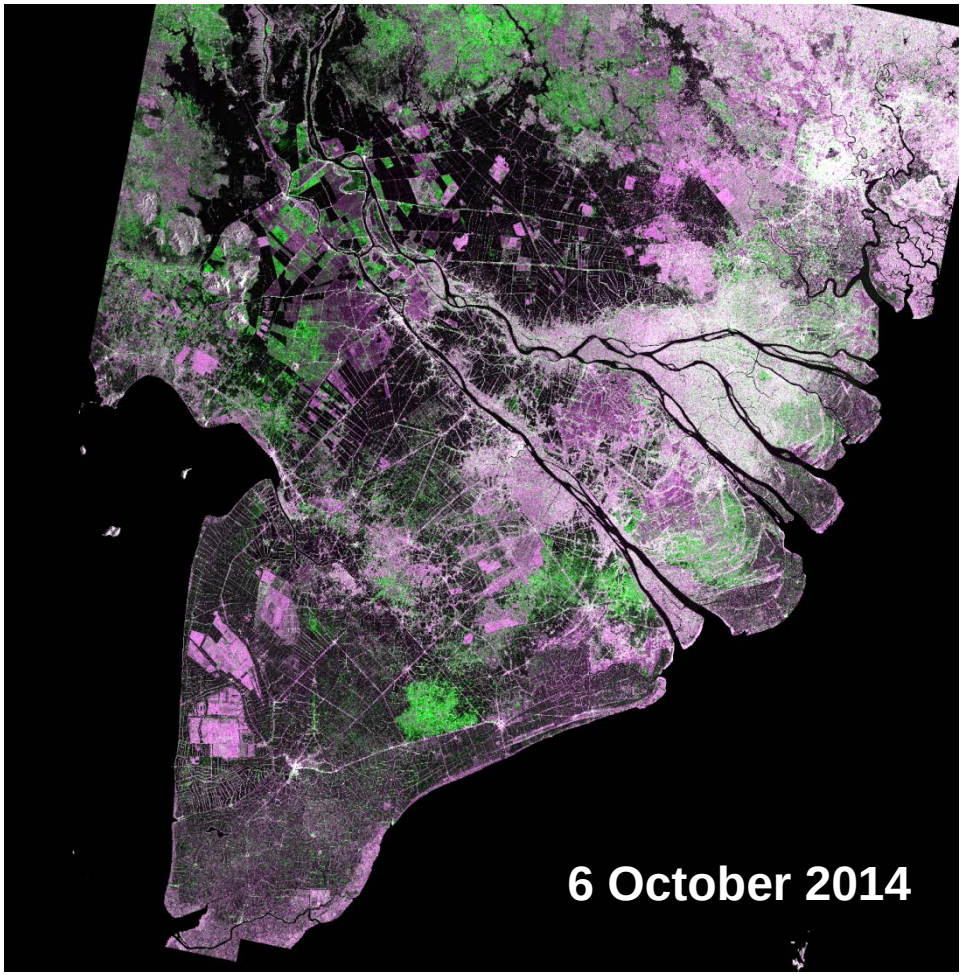


Sentinel-1 covers the Earth every 6/12/24 days



Here comes Sentinel-1





Every 12 days except few gaps
6 days with Setinel-1B since 1 Oct 2016

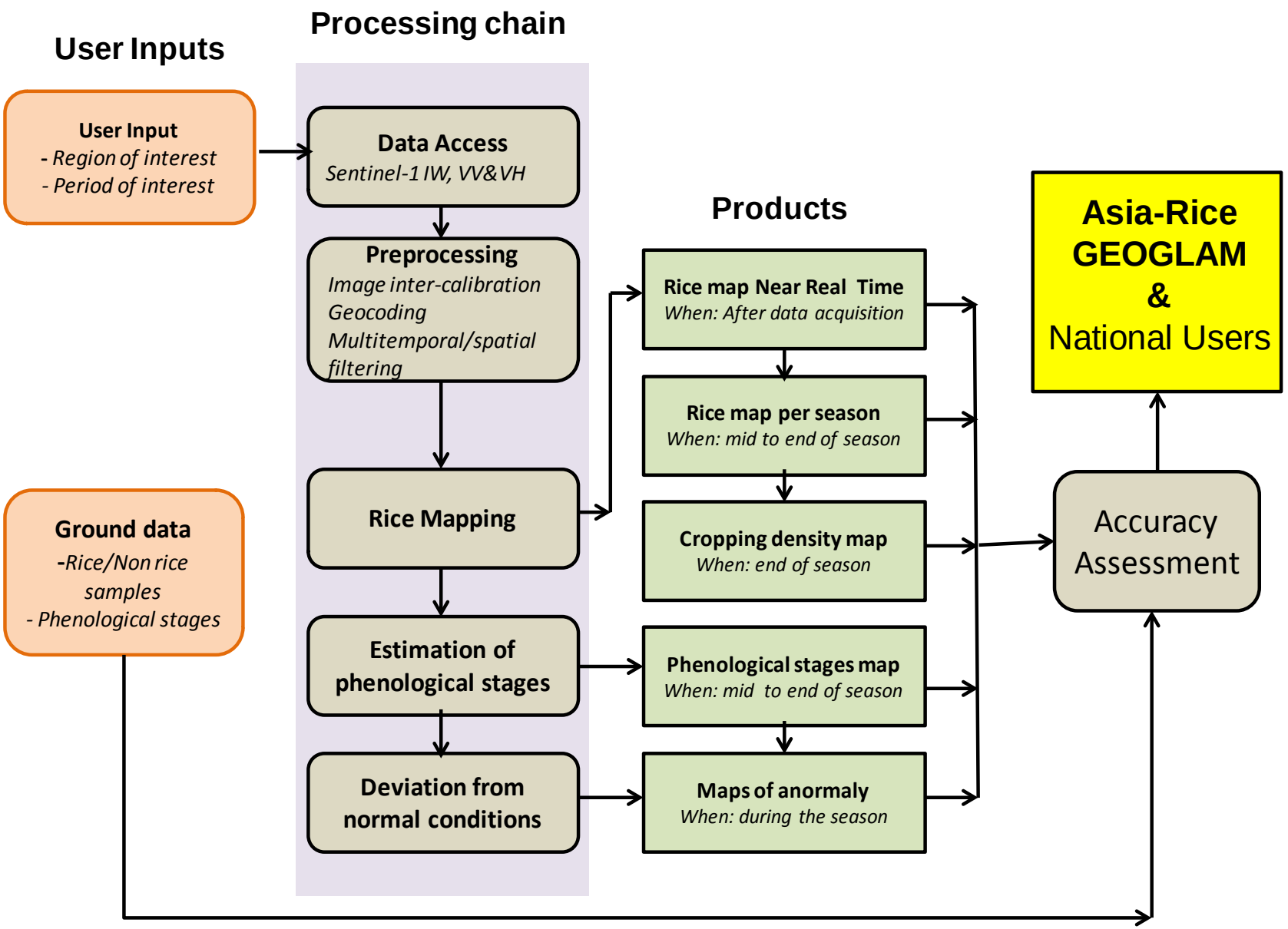
From S1 data to user products

Rice monitoring products

Rice area, rice cropping density, growth status

Users	Temporal scale	Spatial scale
GEOGLAM/Asia Rice	**Monthly** reporting	National to global
National agencies	**Monthly to yearly**	Commune, district, province, country
Farmer groups	**NRT** (on IT platform)	Village, commune, district, province

GEORICE Workplan



Research needed for method development

1. To understand the S1 response of rice fields with
   - specific frequency, polarisations , incidence angle
   - diversity of rice ecosystems over 250x250 km scenes

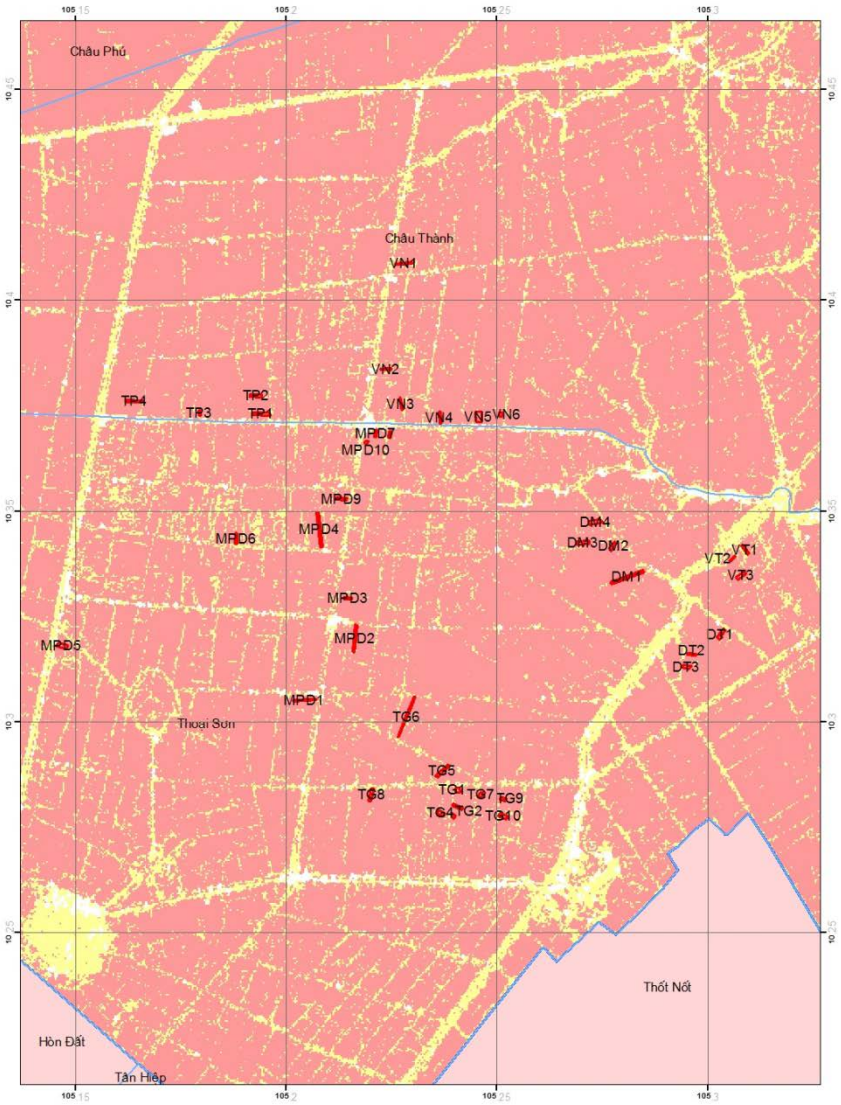
2. To exploit dense time series of data (12 or 6 days)

3. To develop methods for mapping of rice grown areas, monitoring of phenological stages, growth anomaly

4. To deal with large amount of data (at 20 m resolution)

5. To derive useful and timely information to users

In situ data needed for method training

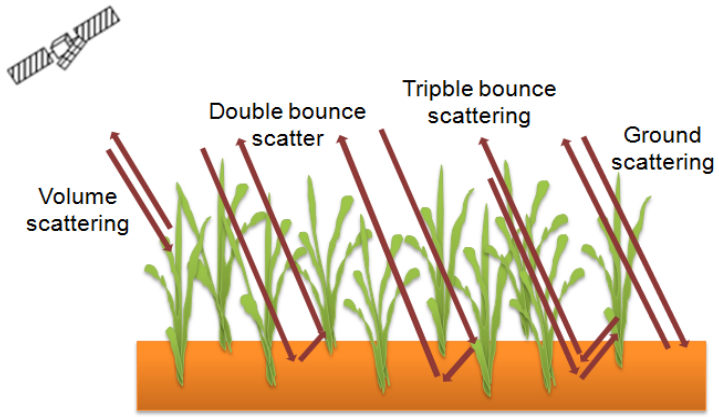


Survey by the University of An Giang
In collaboration with the VN Satellite Technology and Applications (STAC) and CESBIO

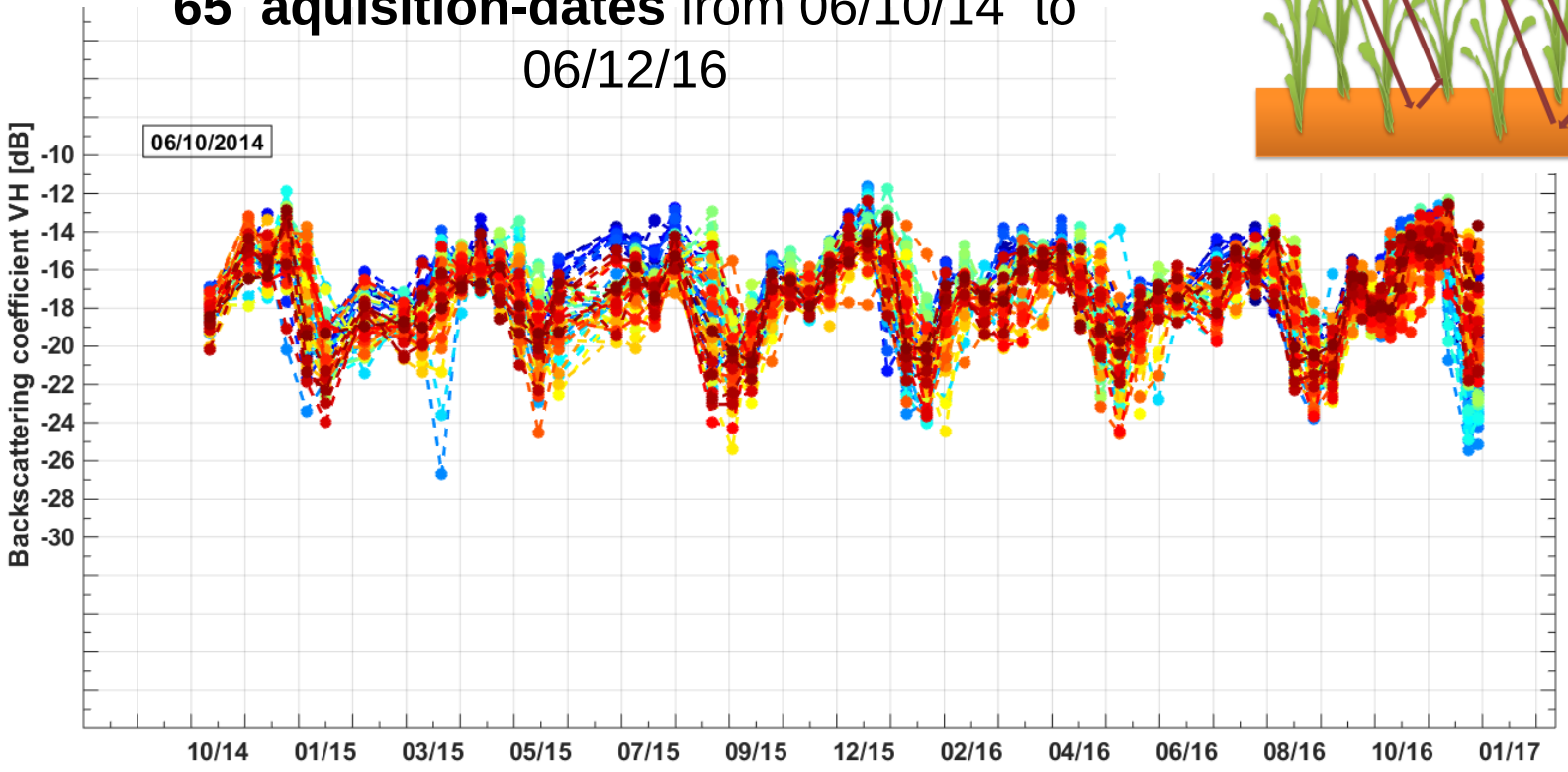
General:
Day of sowing
Rice varieties
Planting density
Harvest date
Rice Yield

Detailed:
Height
Biomass
LAI
Growth stage
Water management
Plant description (dimensions)

Understanding EO measurements



60 rice fields in An Giang province
65 aquisition-dates from 06/10/14 to 06/12/16



VH backscatter at 30-45° of incidence

(Sentinel-1 IW mode)

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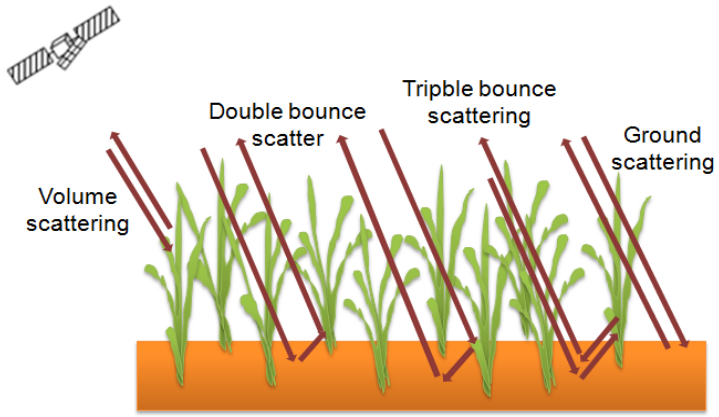
Understanding EO measurements



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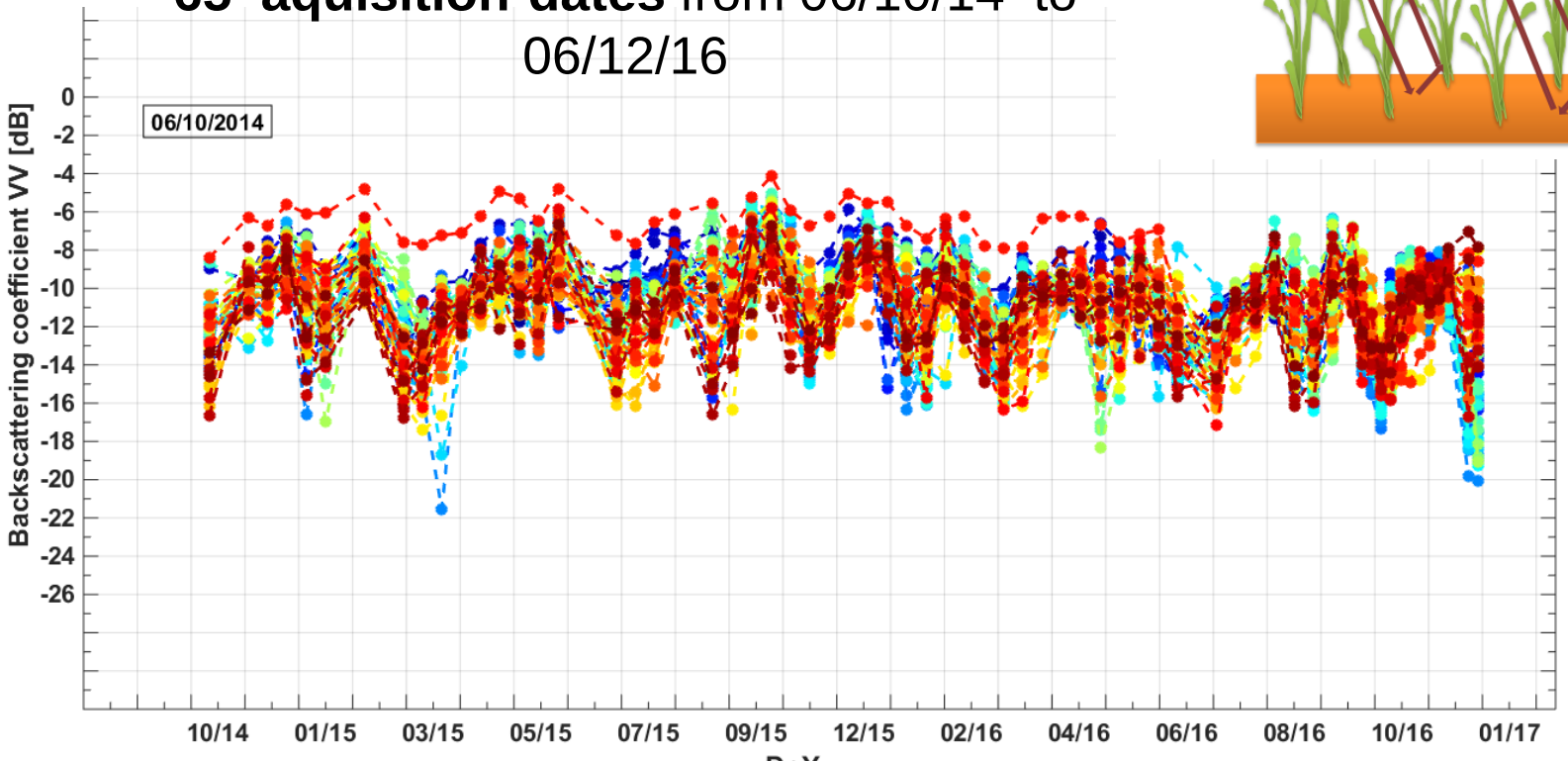

VV backscatter at 30-45° of incidence

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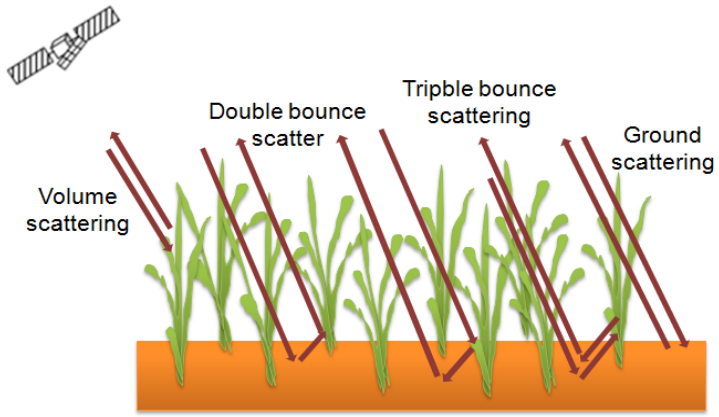

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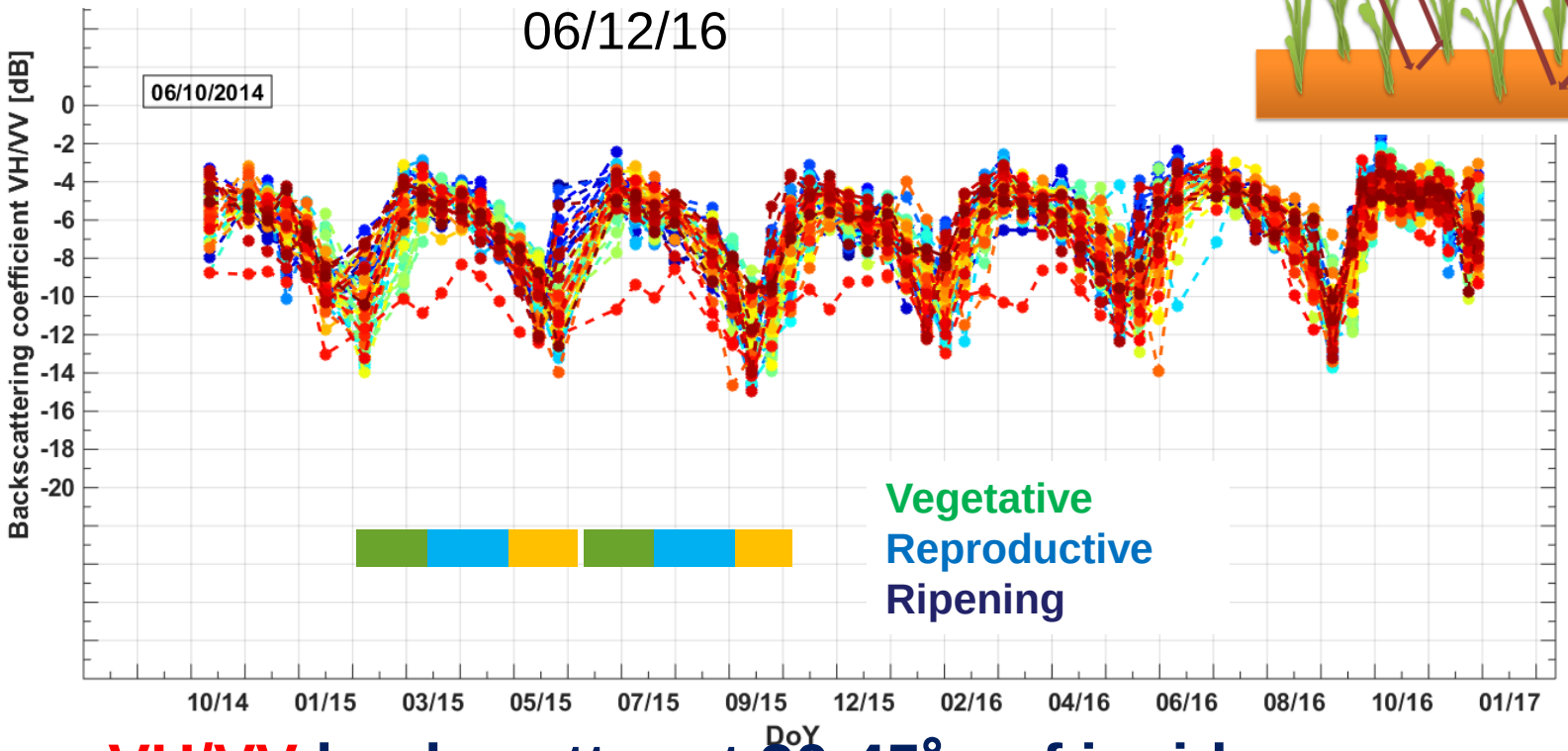

VH/VV backscatter at 30-45° of incidence

(Sentinel-1 IW mode)

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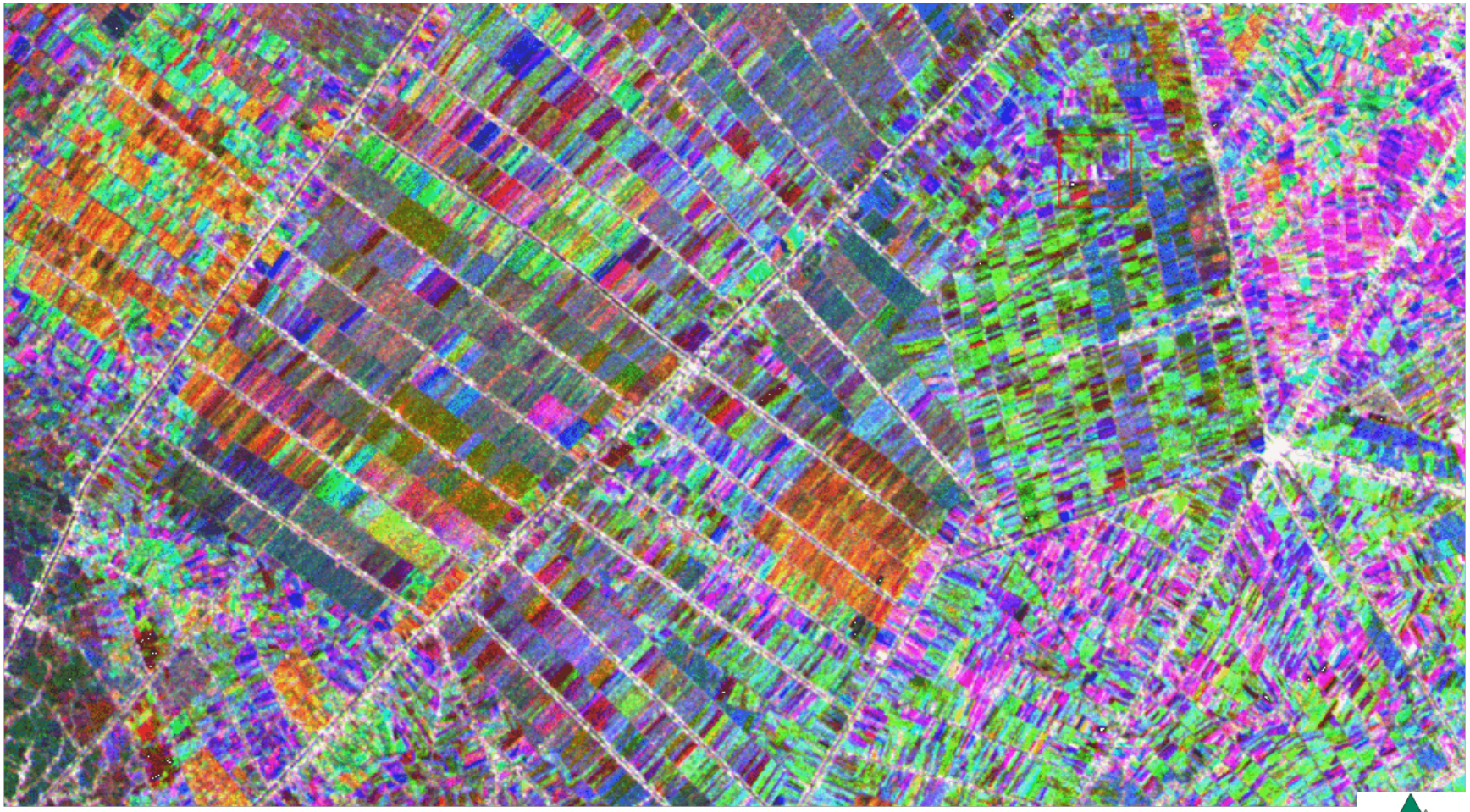
S1 time series of rice fields

Examples of RGB combinations of different dates of Sentinel-1 over rice fields in the An Giang province



Can we provide rice phenology for field management and production models ?

Needed: Solar Radiation
Temperature

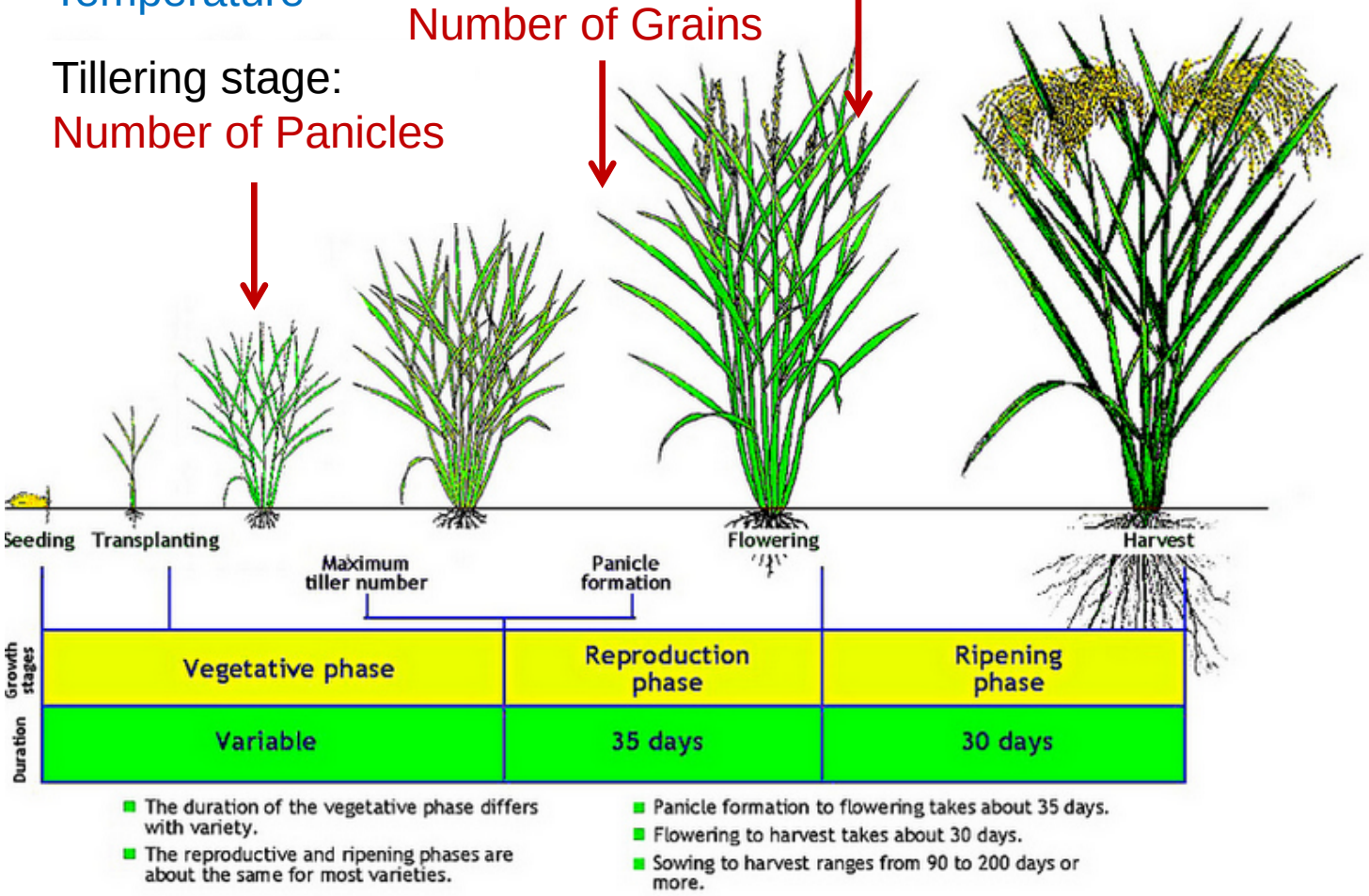
Tillering stage:
Number of Panicles

Water

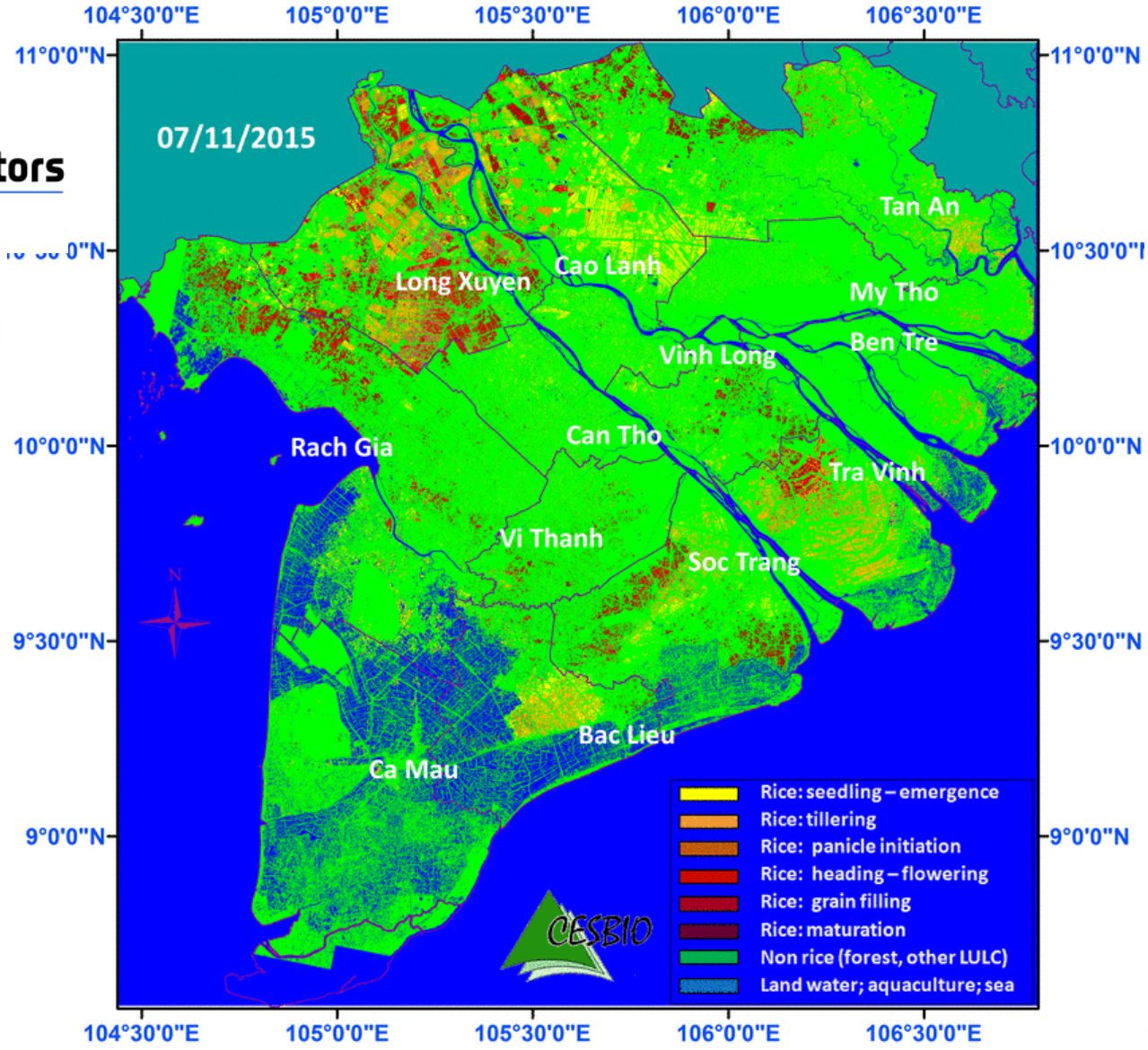
Panicle formation:
Number of Grains

Water
Solar Radiation

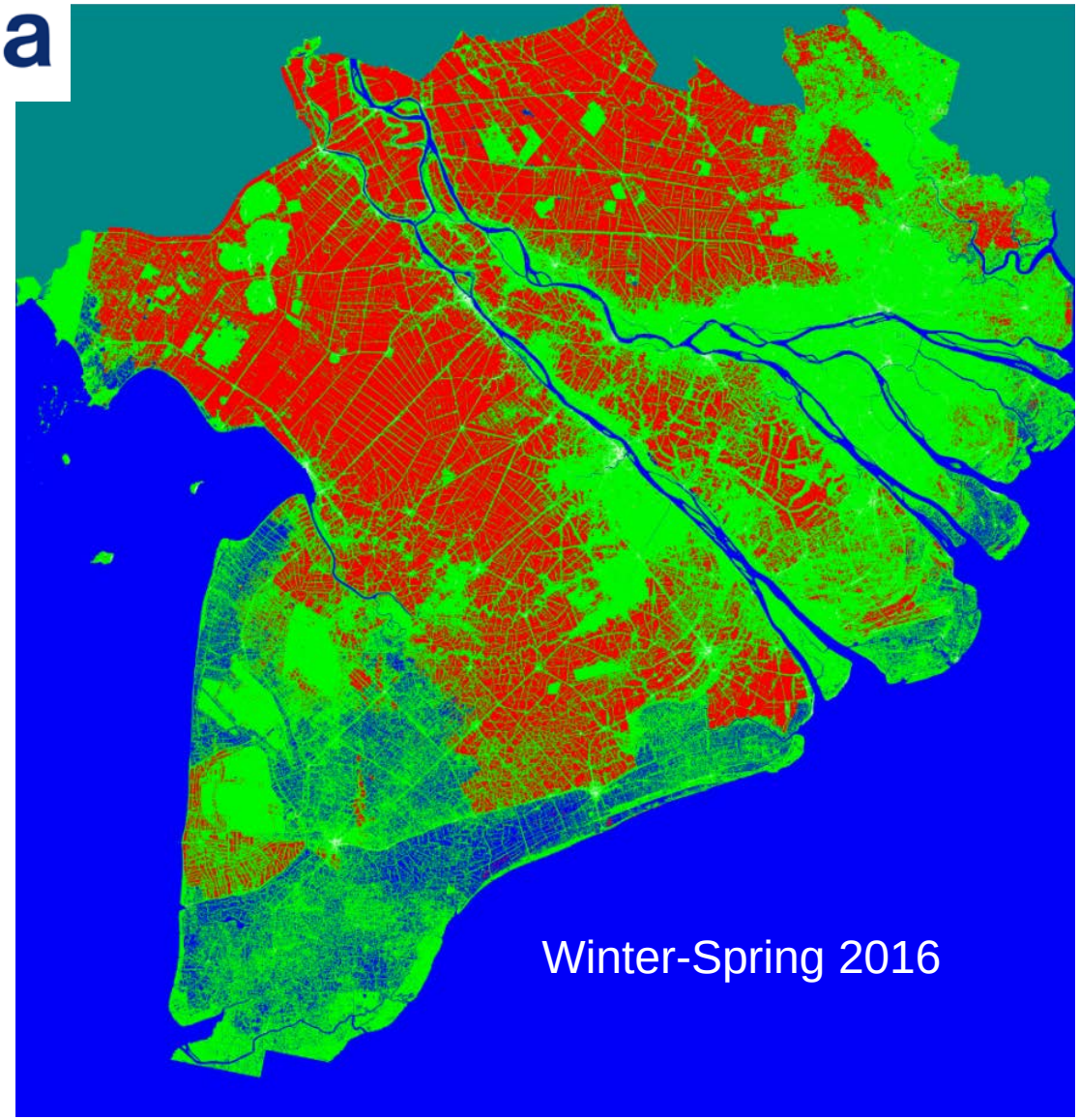
Grain Filling Stage:
Weight of Grains



Mapping rice development stage



Maps and statistics

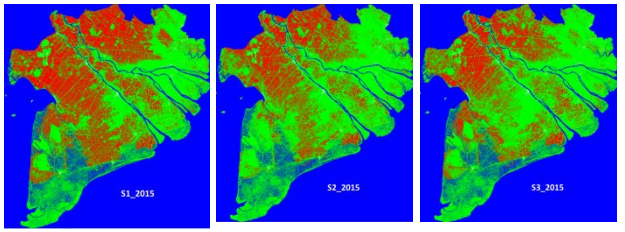


By March 2016:
1,39 M ha of rice grown area

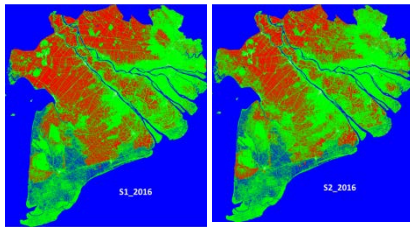
The prevision of the Ministry of Agriculture And Rural Development For Winter-Spring rice **1.56 M ha**

Frequent mapping for field management, statistics, and production indicators

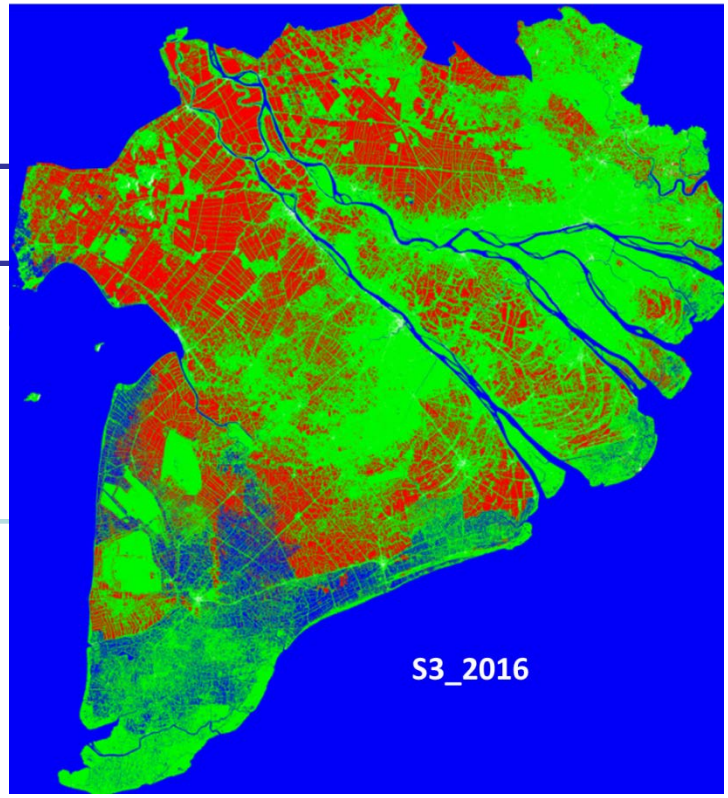
Seasons 1, 2, 3
2015



Seasons 1, 2, 3
2016



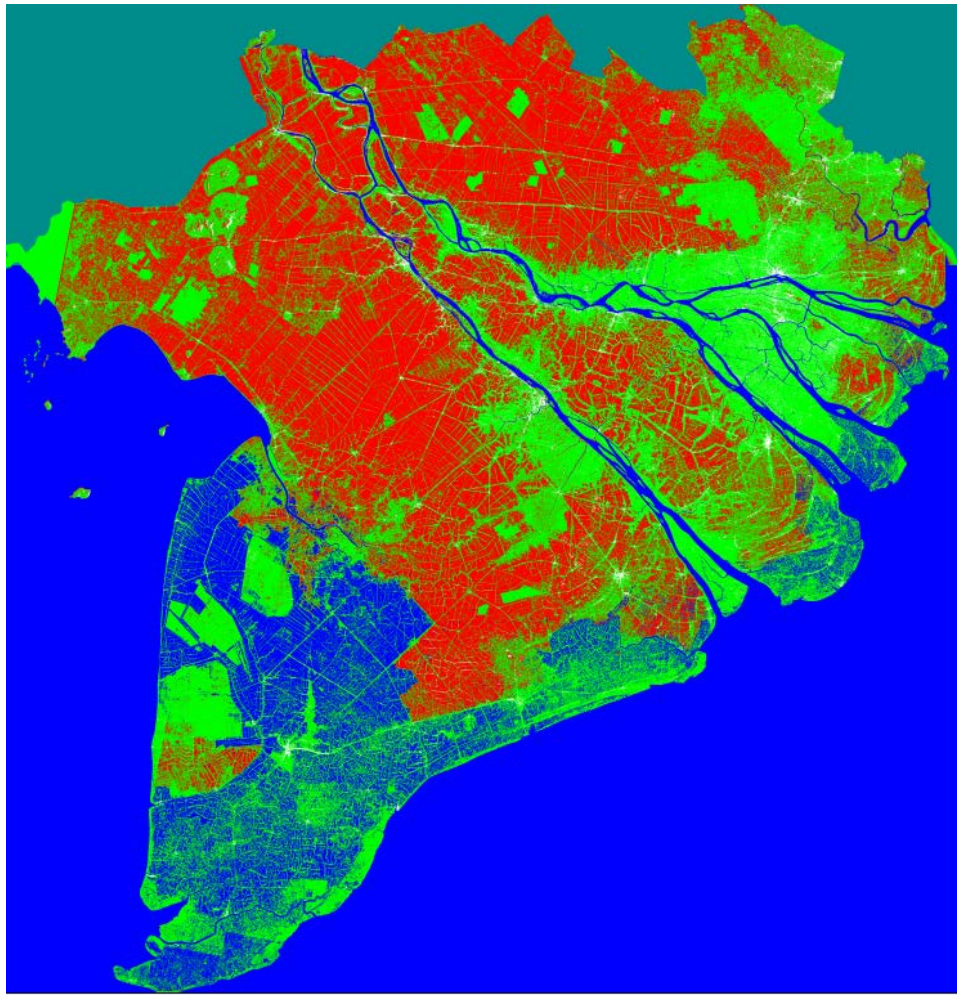
30/12/2016



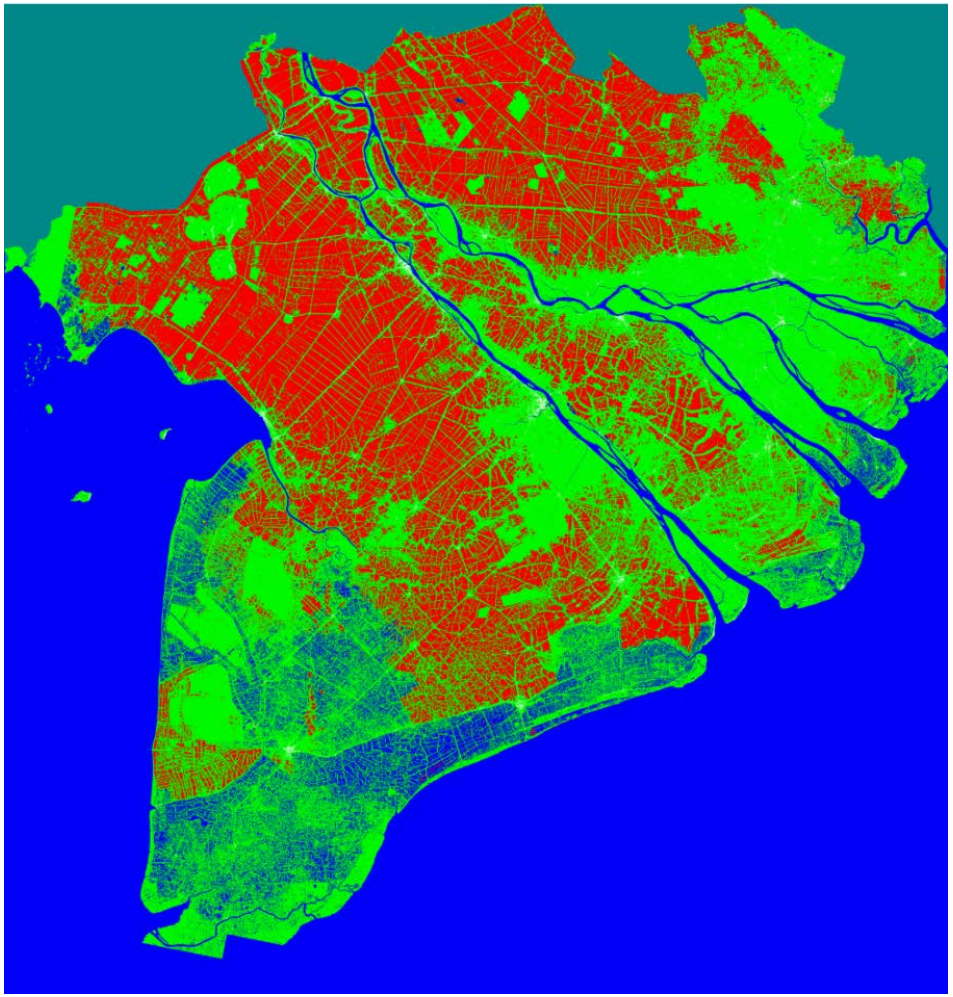
→ Every 12 (6) days mapping
→ Statistics per season
→ Detection of changes (due to El Nino, 2015-2016)

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

Winter-Spring 2015



Winter-Spring 2016



276000 ha less in 2016 compared to 2015 (1.39 M ha vs 1.67 M ha)

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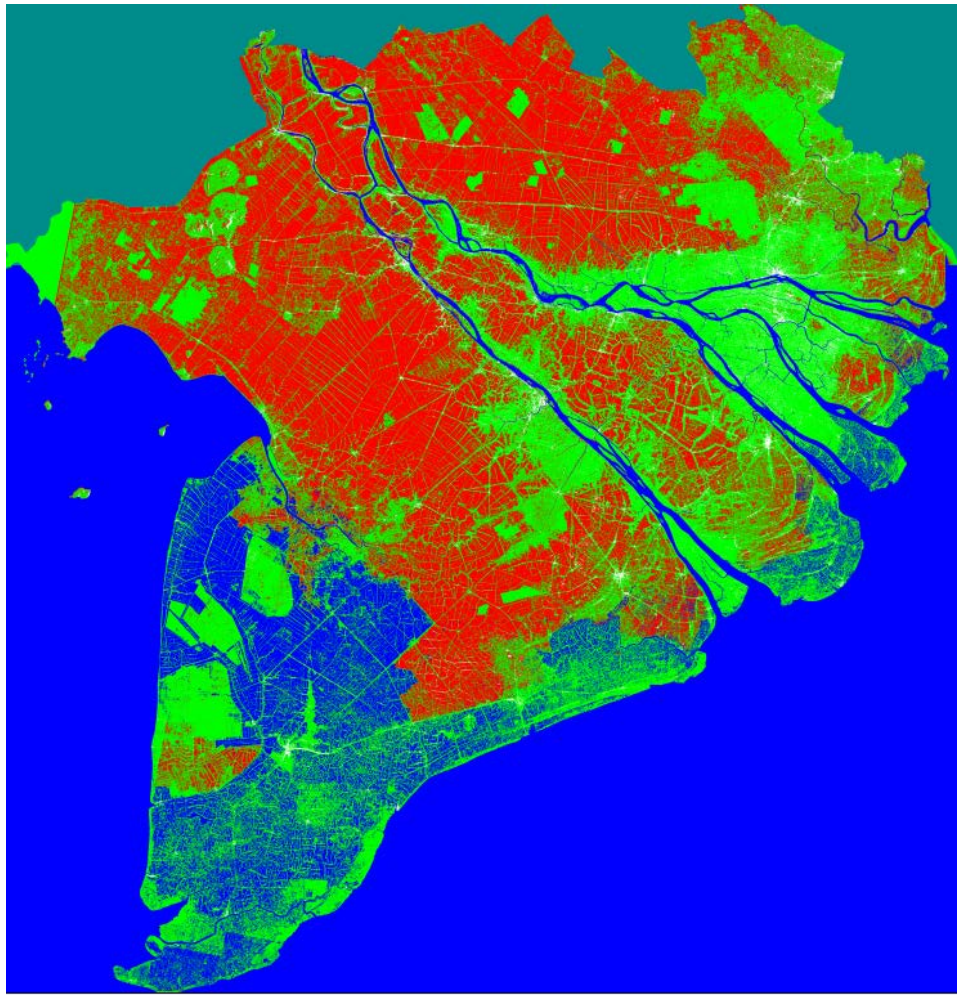
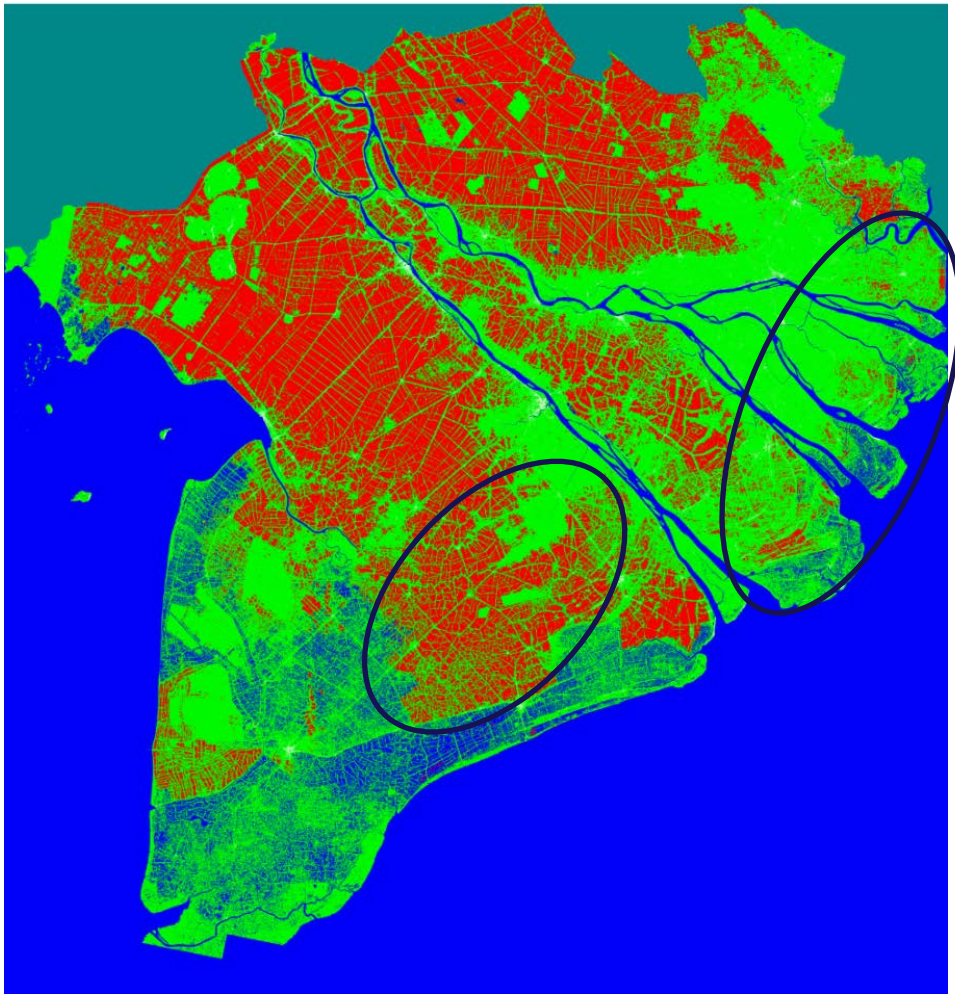


Winter-Spring 2016



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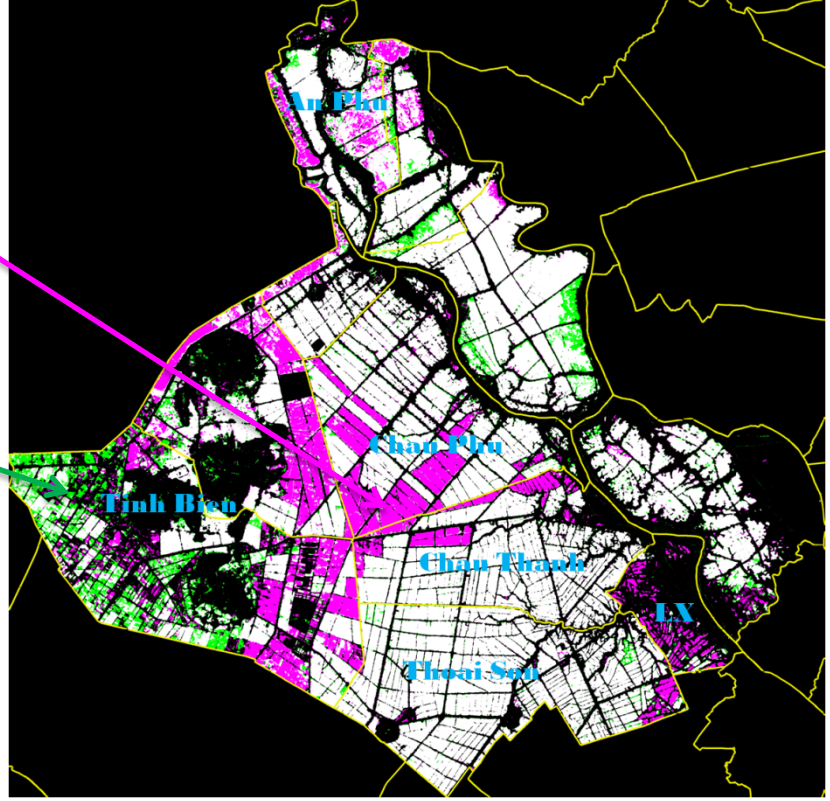
No rice in 2016, flooded fields

No rice in 2015, because of drought

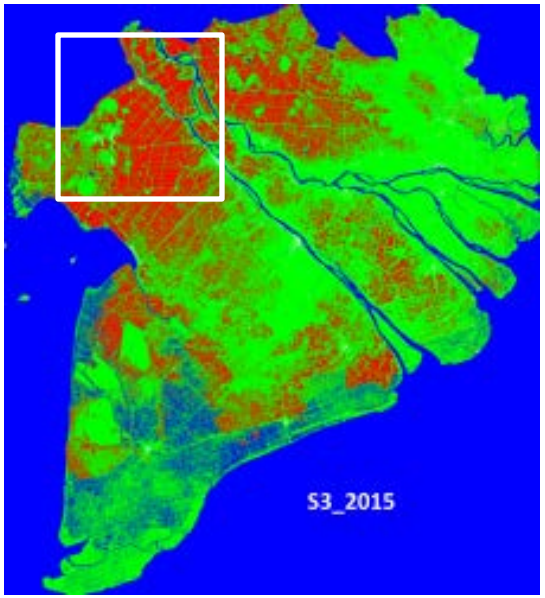


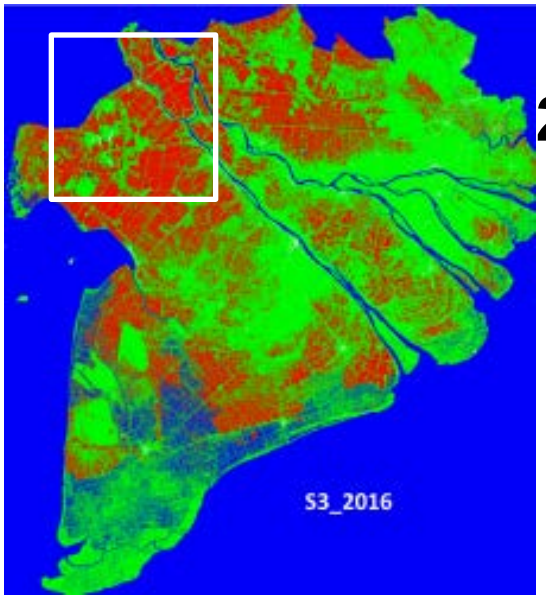
R: S3- 2015

G: S3- 2016

B: S3- 2015

2015





2016

Rice season 3

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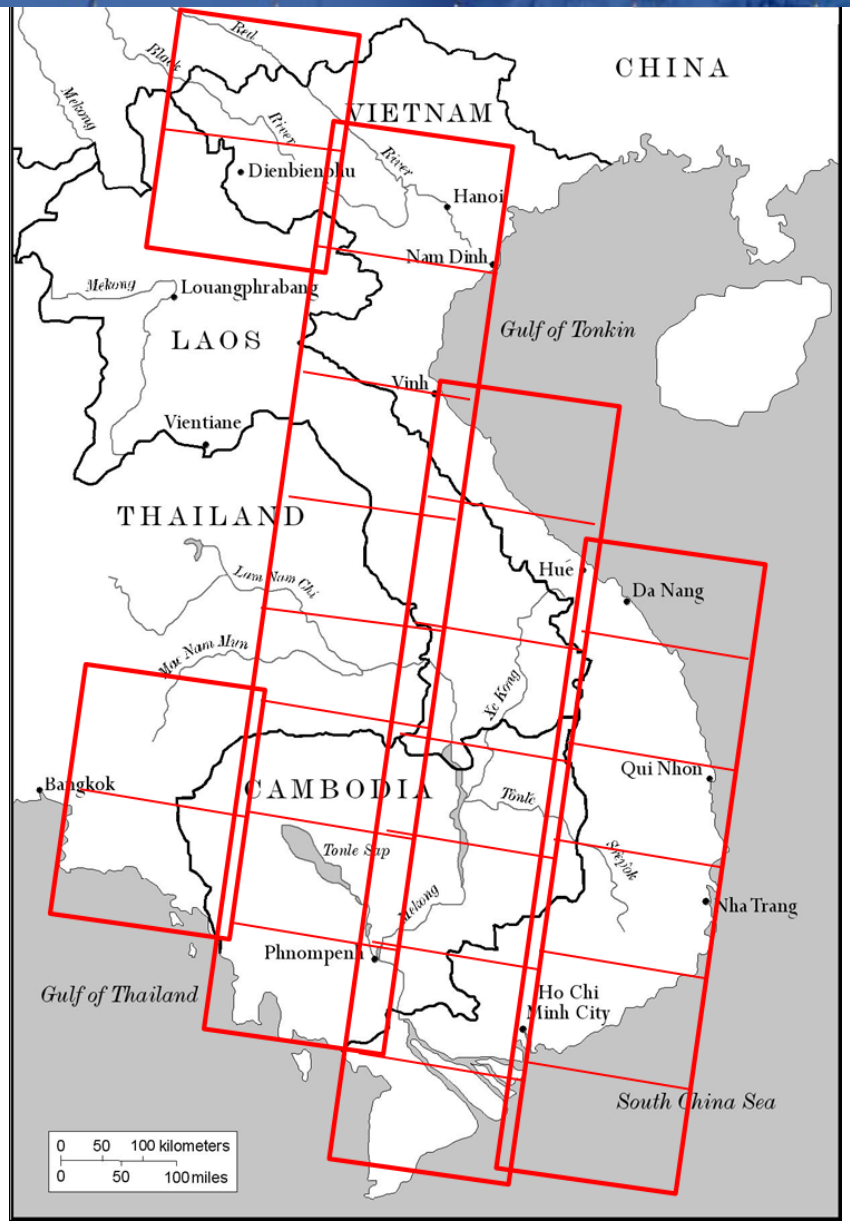
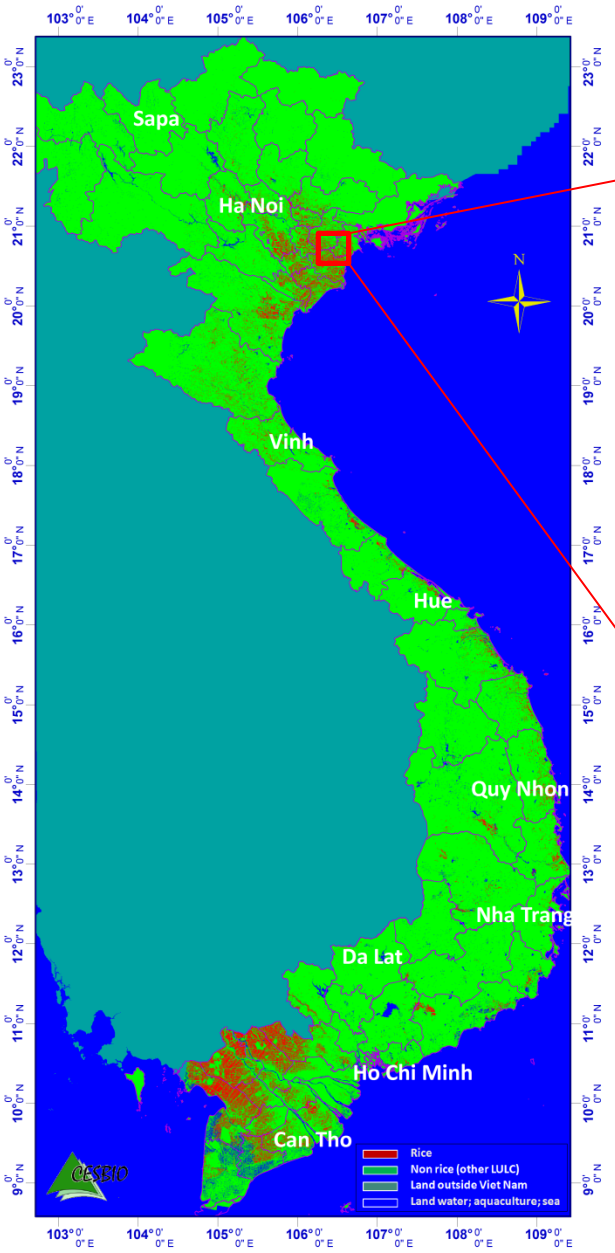
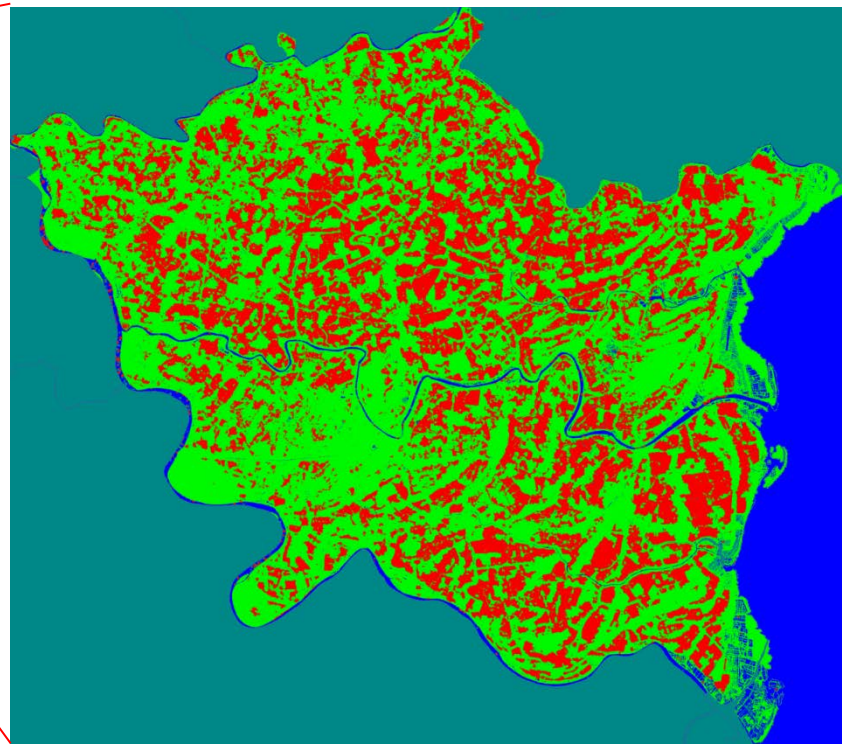
Mapping at country scale



Winter-Spring Rice 2016





Thai Binh

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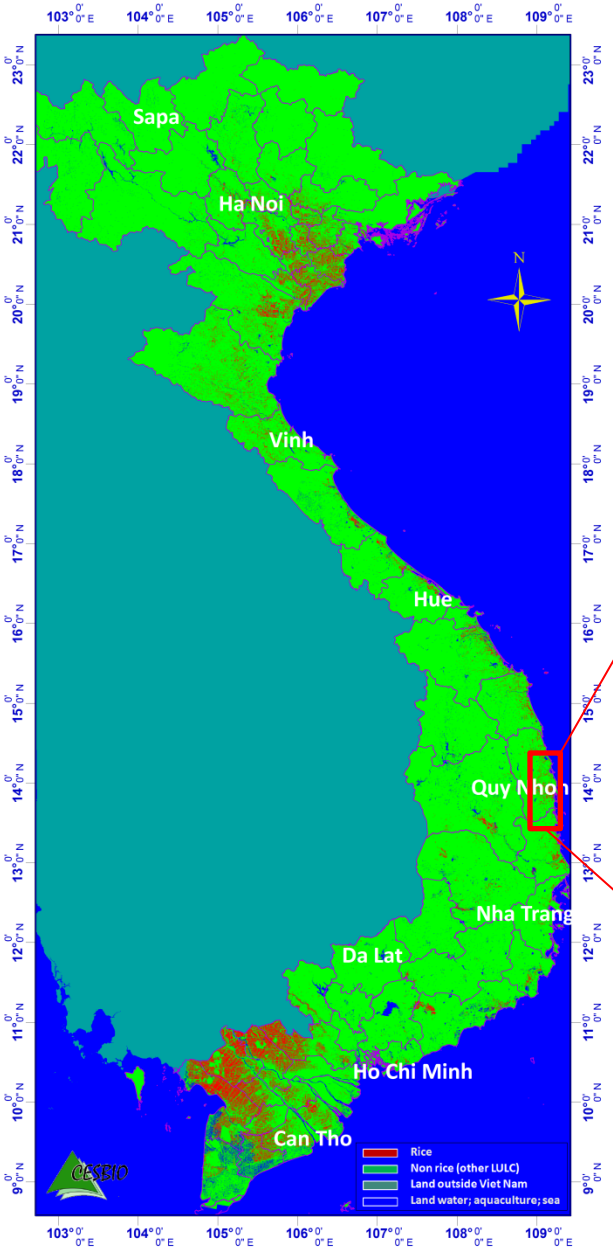
Winter-Spring Rice 2016



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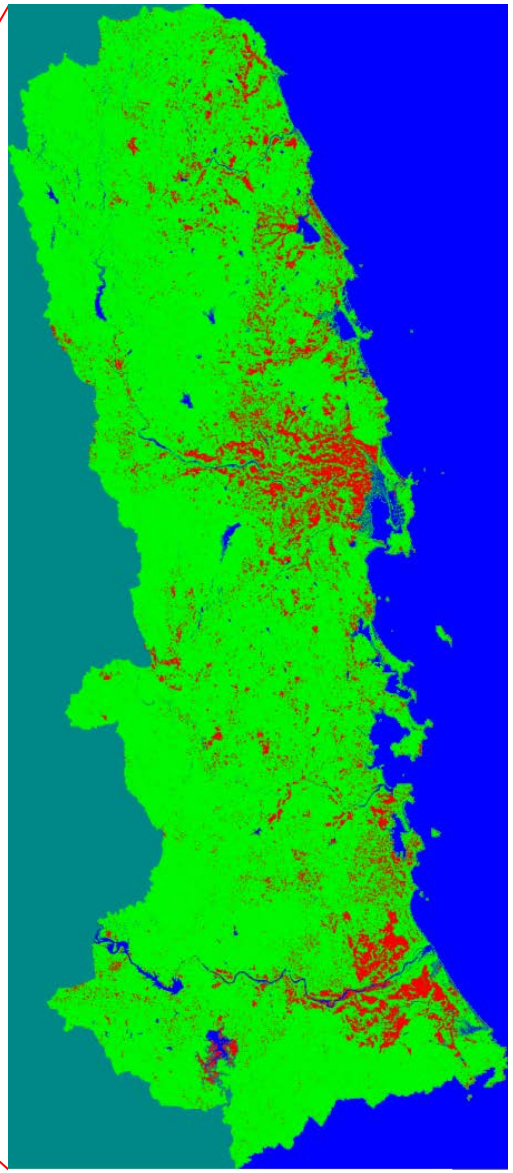
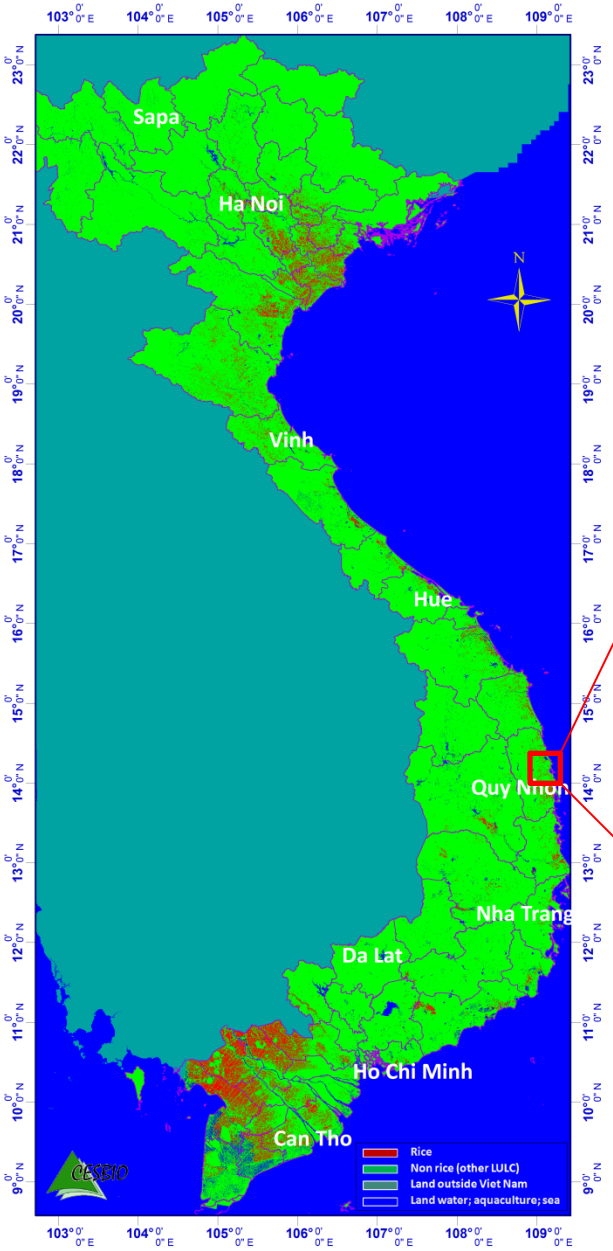
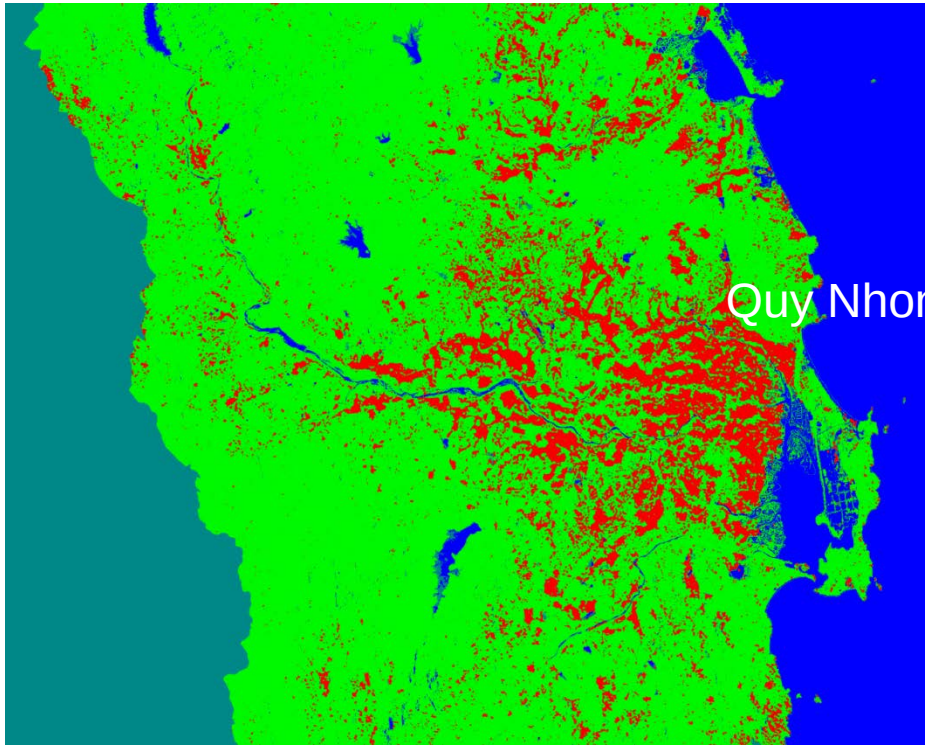


Quy Nhon

Phu Yen

Winter-Spring Rice 2016





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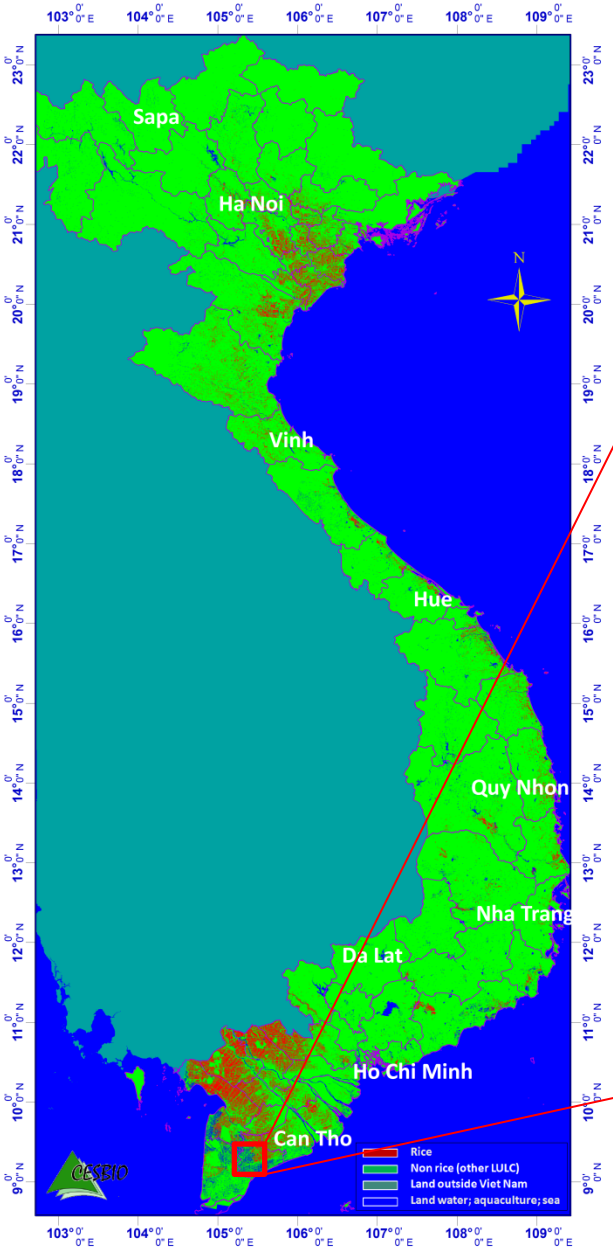
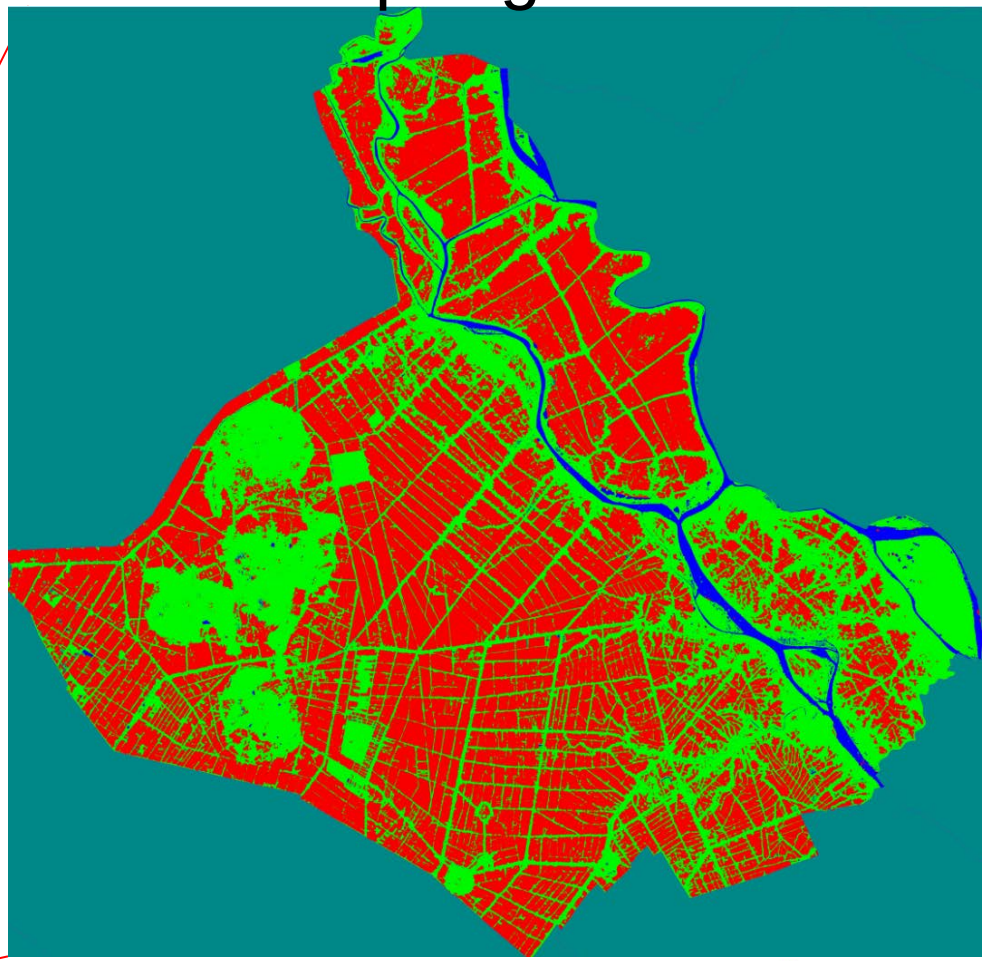
Winter-Spring Rice 2016





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An Giang

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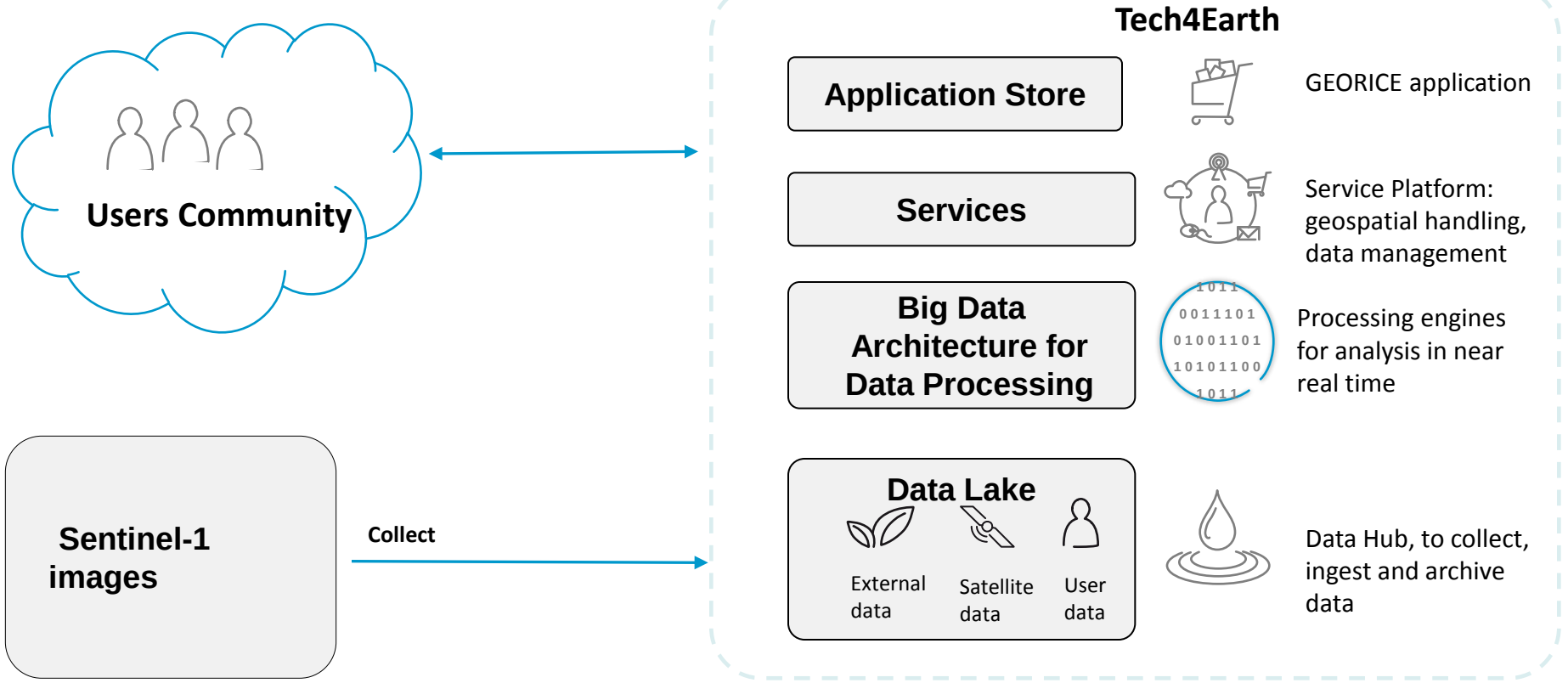
GEORICE implementation



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Capgemini
CONSULTING.TECHNOLOGY.OUTSOURCING

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User workshops for project presentation, result evaluation and training

CanTho workshop, 24-25 October 2016

Strategic Issues to bring R&D results into operation

1. User requirement issues

Convince and involve the 'real' users and develop methods to meet their requirements (Institutions, Ministeries..)

2. Information sharing and Coordination issues

- **Promote development and cross validation on different sites, different countries**
- **Promote coordination of supported projects**

3. Sustained support issues

- **Promote support from institutions** such as, ADB, UN-ESCAP, MRC, CEOS, and GEO, and **contribution/endorsement from national monitoring systems**