Regional rice monitoring in South East Asia using Sentinel-1 data -The GeoRice project

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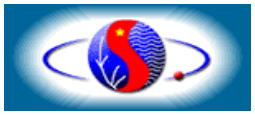
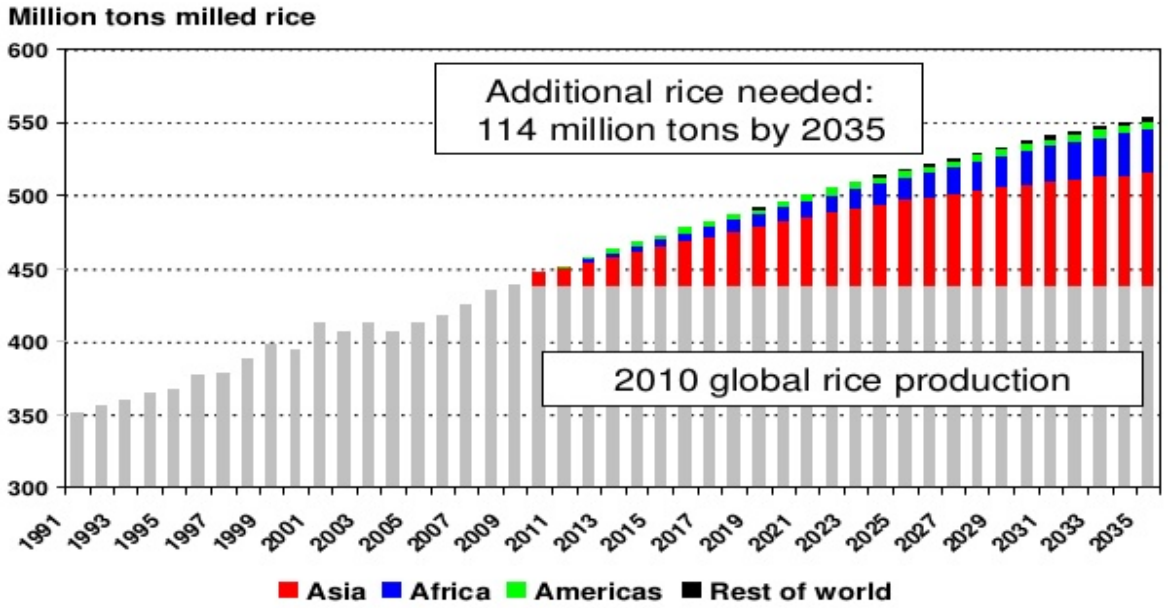


Land Use/Cover Changes, Environment and Emissions in South/Southeast Asia
An International Regional Science Meeting, 22-24 July, 2019, Johor Bahru, Malaysia

GeoRice

Rice: a global concern for food security

Rice is the most critical staple food for more than half of humanity, with the majority in developing world (90% in Asia)



Global rice production increases needed to meet demand by 2035 (source IRRI)

Sustainable Development Goal 2

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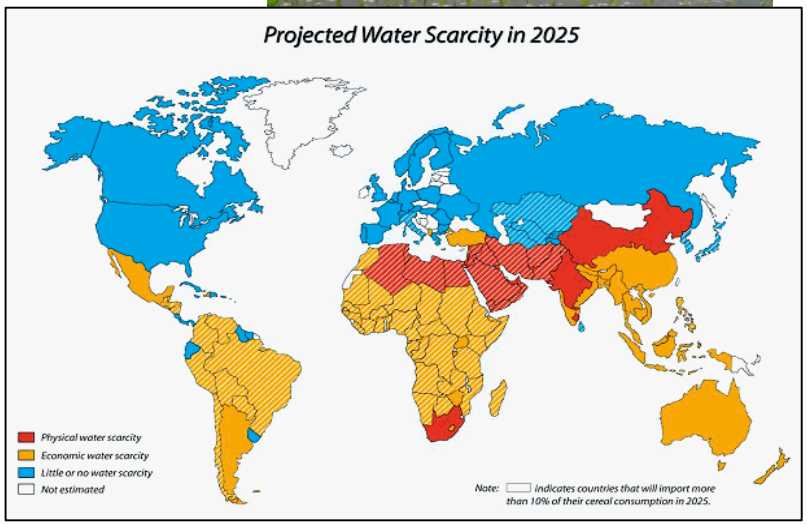
GeoRice

More irrigated rice requires more water

- More than 90% of the world's rice production is from irrigated or rainfed lowland rice fields.
- Total water input to rice fields is 2-3 times more than other cereals
- Irrigated rice receives 34–43% of the total world's irrigation water.

Worldwide, water for agriculture is increasingly scarce. It is estimated that, by 2025, 15–20 million ha of irrigated rice will suffer some degree of water scarcity.

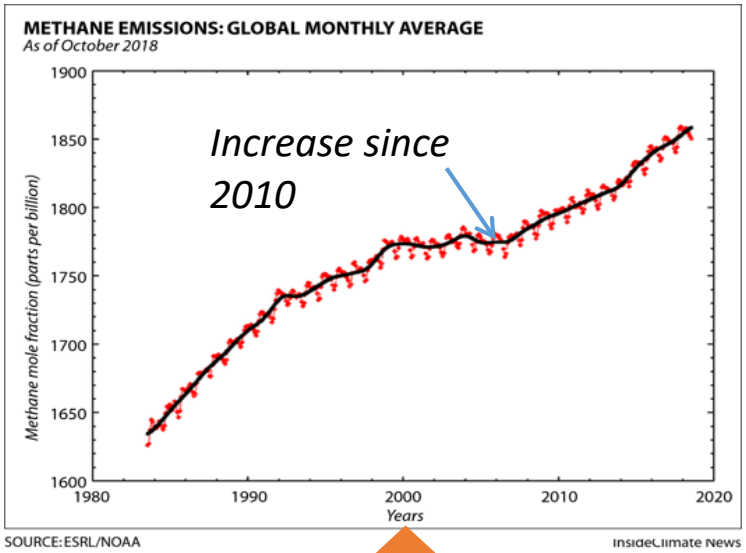


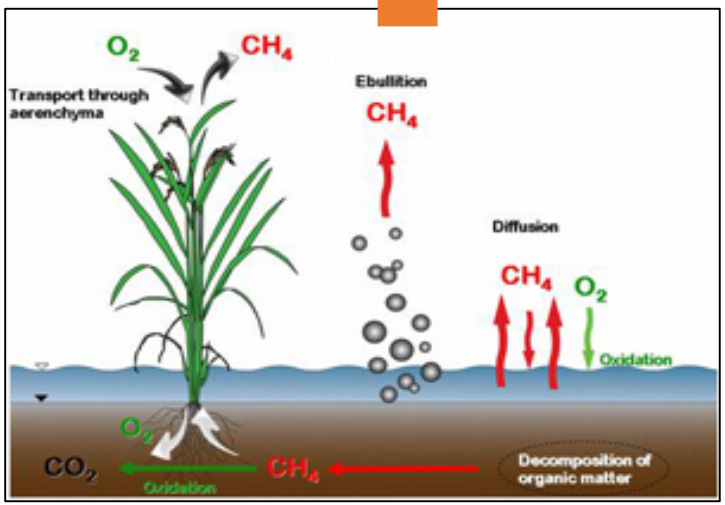
Source IWMI

Sustainable Development Goal 6

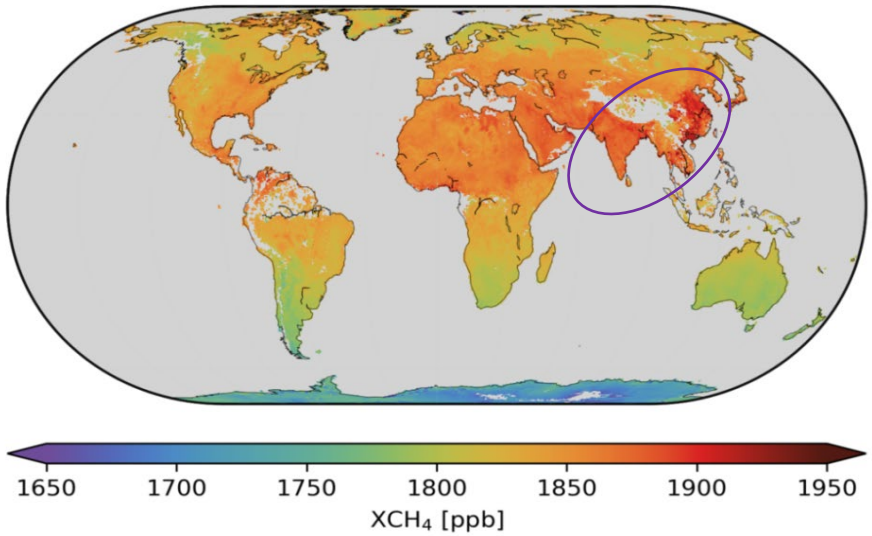
More irrigated rice generates more GHG

Rice fields : sources of methane





Atmospheric methane by Sentinel-5P mission -March 2019



Sustainable Development Goal 13

Need Earth Observation for Rice monitoring to support:

- Food Security: For Rice production estimates and Early warning (Asia-Rice/ GEOGLAM objectives) at local, national, global scale

- For the trade-off between productivity, water resources, GHG emission at regional and global scale

In support of Sustainable Development Goals

The GeoRice Project

Objective

To develop and generate Rice monitoring products using Sentinel-1, from local to regional scale

- Rice area,
- Rice cropping density,
- Phenology, growth stage,
- Seasonal and interannual variations

Achievements of the GeoRice phase 1 (2016-2018)

1. Demonstration in the **Mekong Delta**
2. Implantation of rice mapping in DataCube Vietnam
3. M**onthly** rice map currently tested in VN Ministry of Agriculture
   Link with GEOGLAM crop monitor on going

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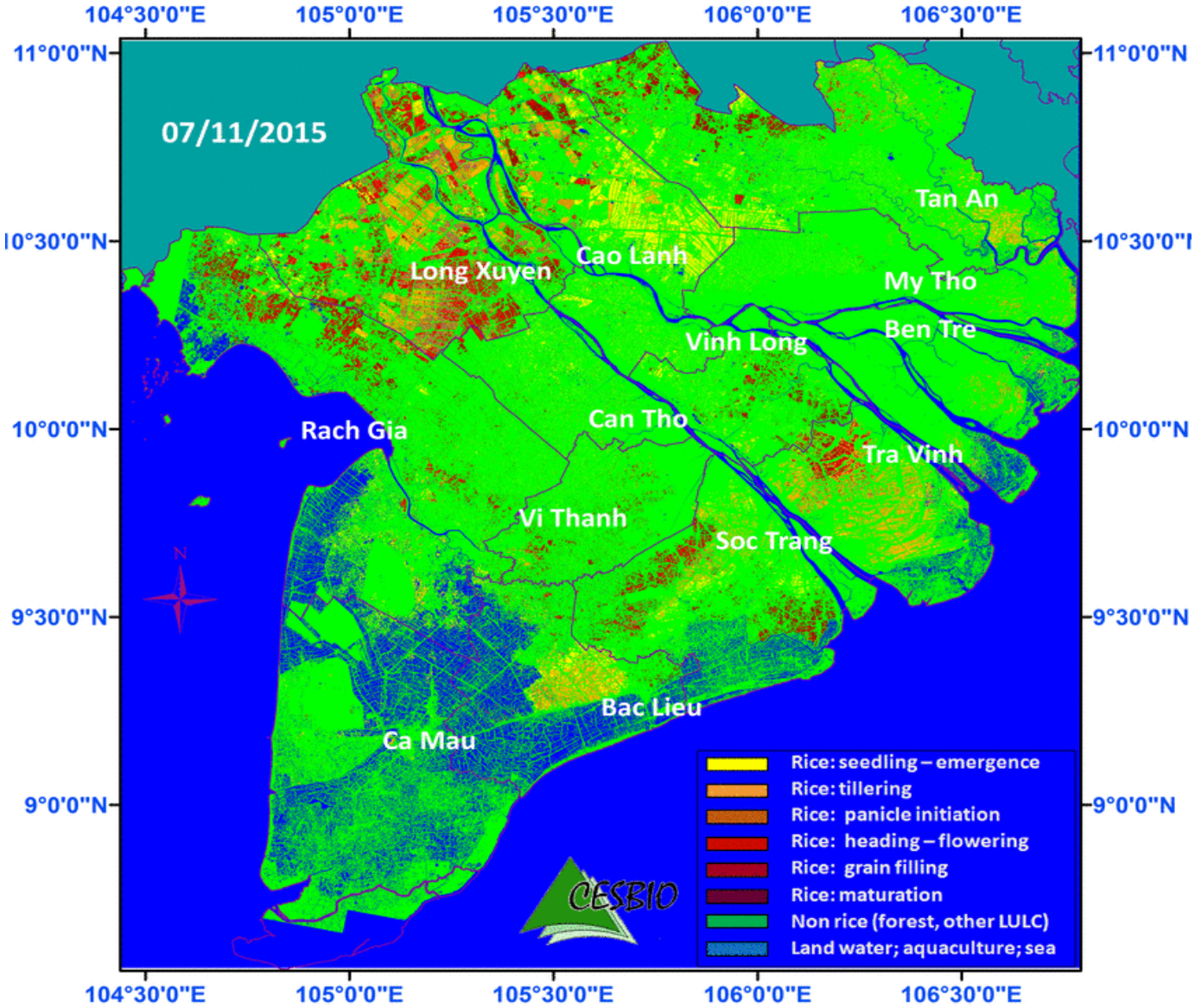
GeoRice

Sentinel-1 to monitor rice growth

Poster by Hoa Phan



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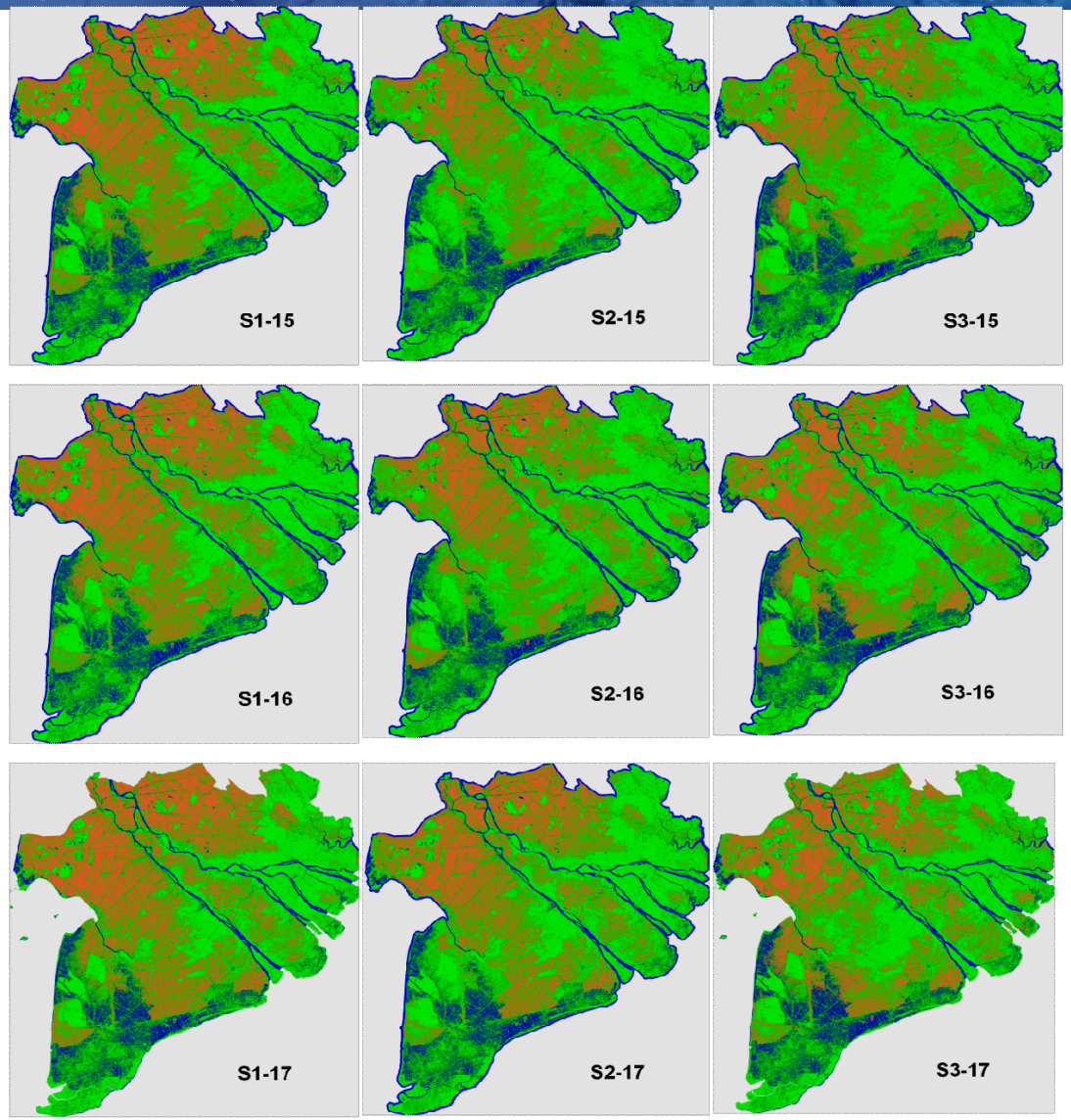
GeoRice

Multi season, multi year mapping and statistics



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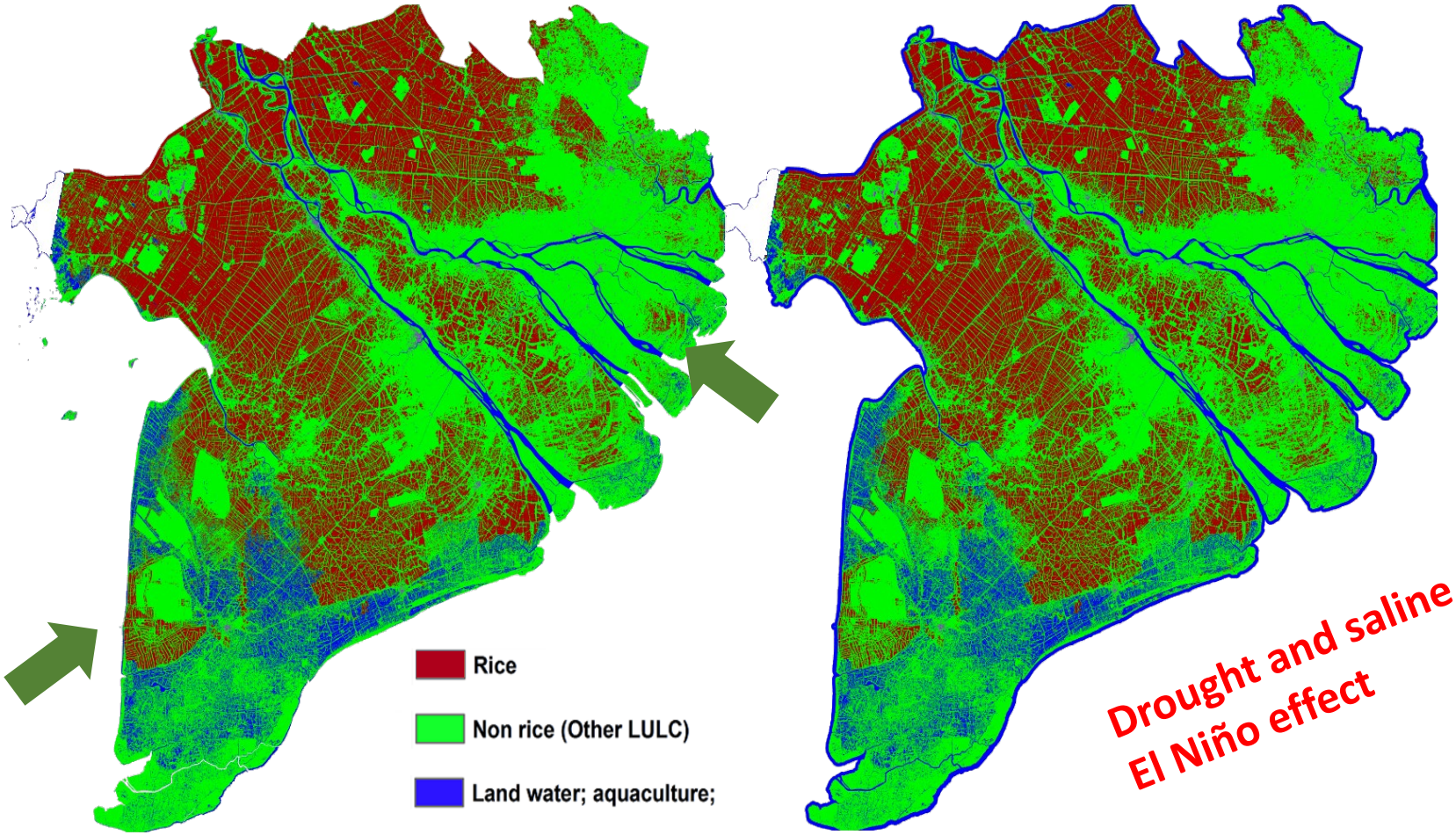
GeoRice

El Niño event reduced rice harvested area

Winter-Spring 2015

Winter-Spring 2016



Drought and saline intrusion
El Niño effect

276000 ha less in 2016 compared to 2015 , 1.39 M ha vs 1.67 M ha (16.7%)

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GeoRice Adaptation measures by provinces

Change in rice crop calendar (2016, VN Mekong Delta)

Summer-Autumn	1	2	3	4	5	6	7	8	9	10	11	12
Ben Tre												
Vinh Long												
Can Tho			22/3									
Tien Giang												
Long An												
Hau Giang												
Hau Giang 2016		9/2						10/8				
An Giang												
Ca Mau					1/5			30/8				
Dong Thap	16/1				15/5							
Tra Vinh 2015												
Tra Vinh 2016												
Bac Lieu						1/6			25/9			
Kien Giang												
Soc Trang												

Traditional sowing date

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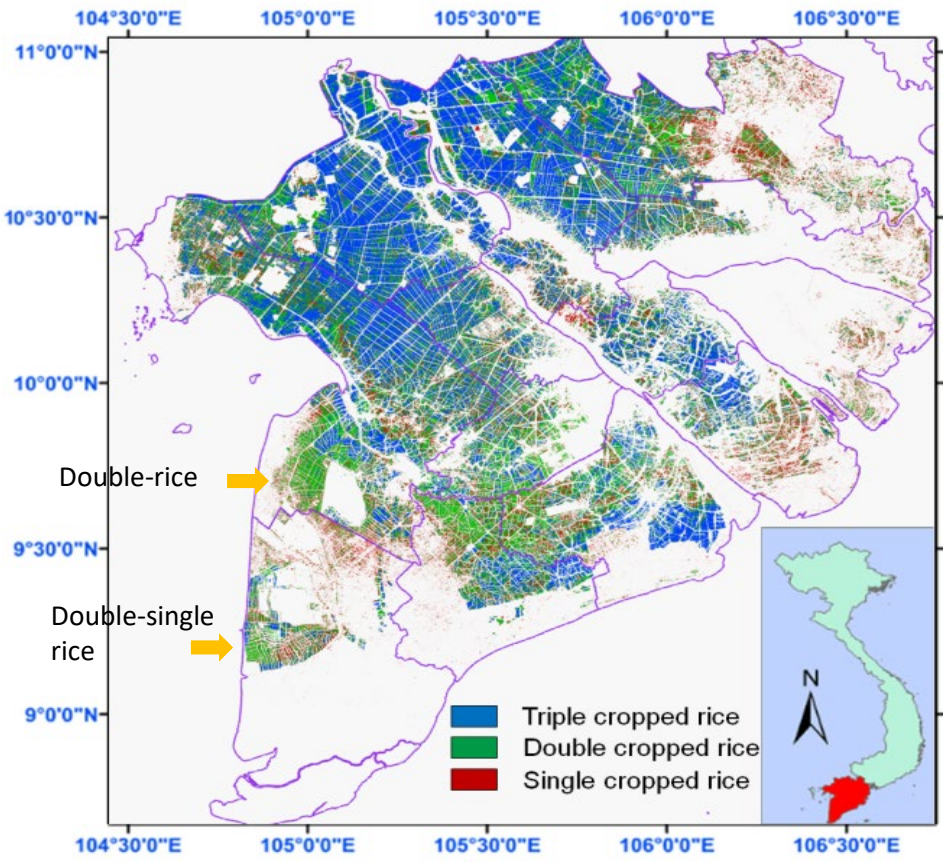
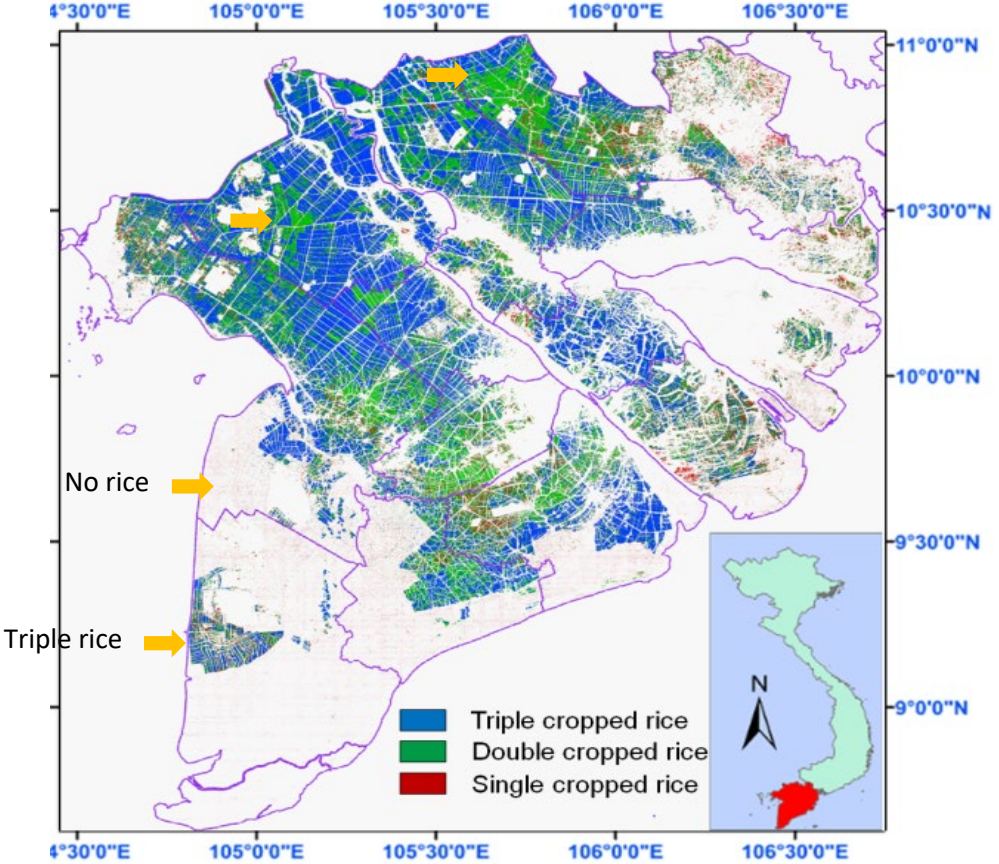
Adaptation measures by provinces

Change in cropping density

2015



2016



GeoRice For mitigation measures: change in irrigation practices 3

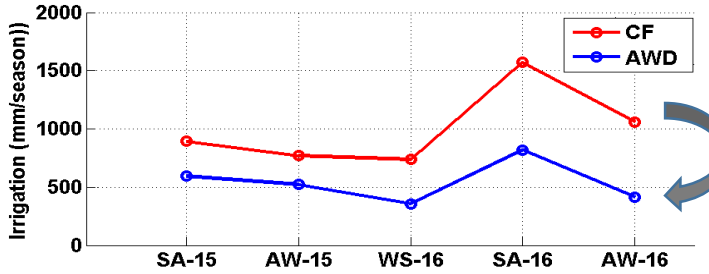
Using EO products in model simulations

Continuous Flooding(CF)

Alternate Wetting Drying (AWD)

Water demand (mm/season)

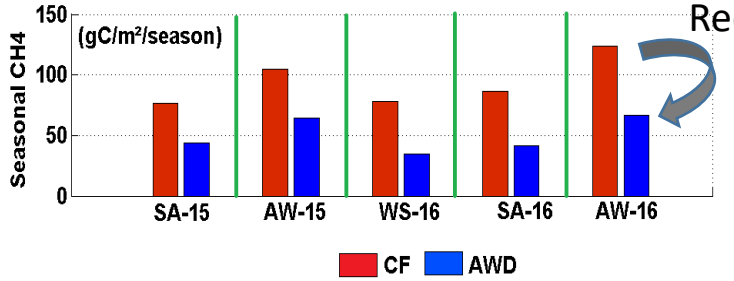
DNDC



Water saving

Methane (gCm²/season)

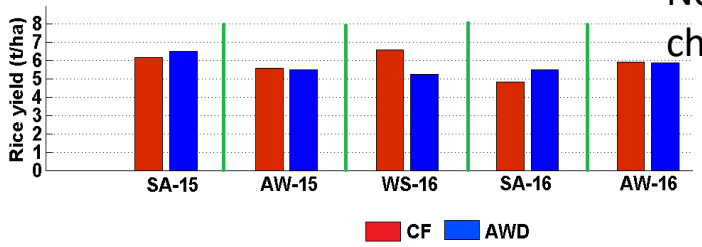
DNDC



Reducing CH4

Rice yield (t/ha)

ORYZA2000



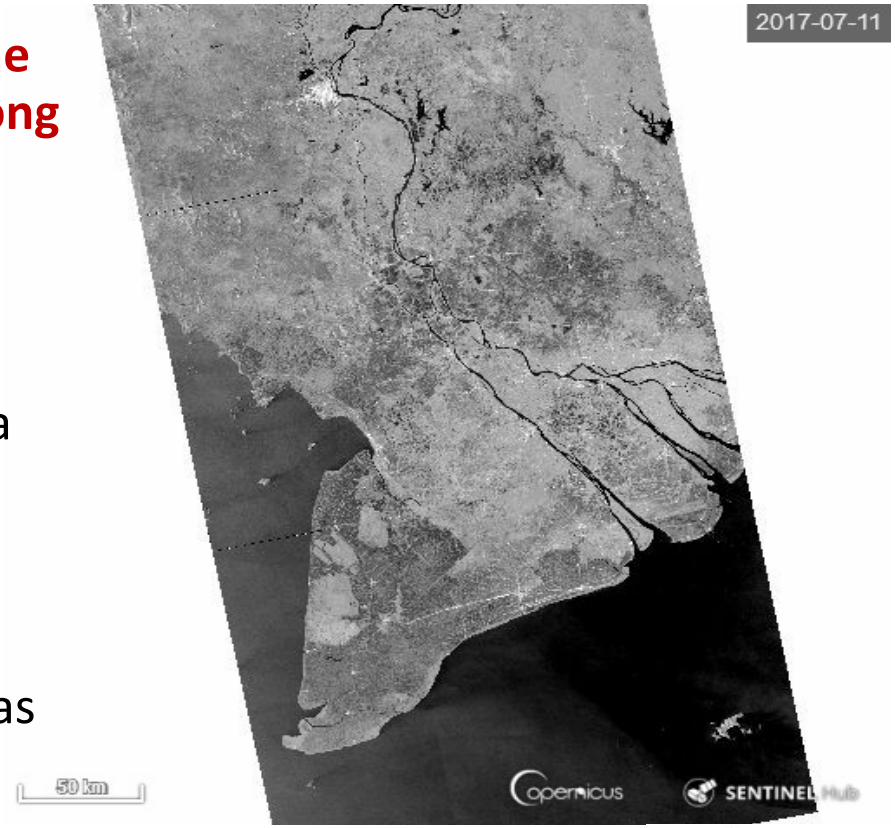
No signicant change

Alternate Wetting Drying reduces water demand, reduces methane emission, without significant change in yield

GeoRice Regional GeoRice Project

Many of the climate change issues impacting rice cultivation are transboundary : water use, flood, drought, salinity intrusion… As well as the market price. These requires harmonized observations over large regions

The Regional GeoRice objective is to up-scale the proof-of-concept for rice monitoring in the Mekong delta to larger regions



GeoRice extension main objectives are to:

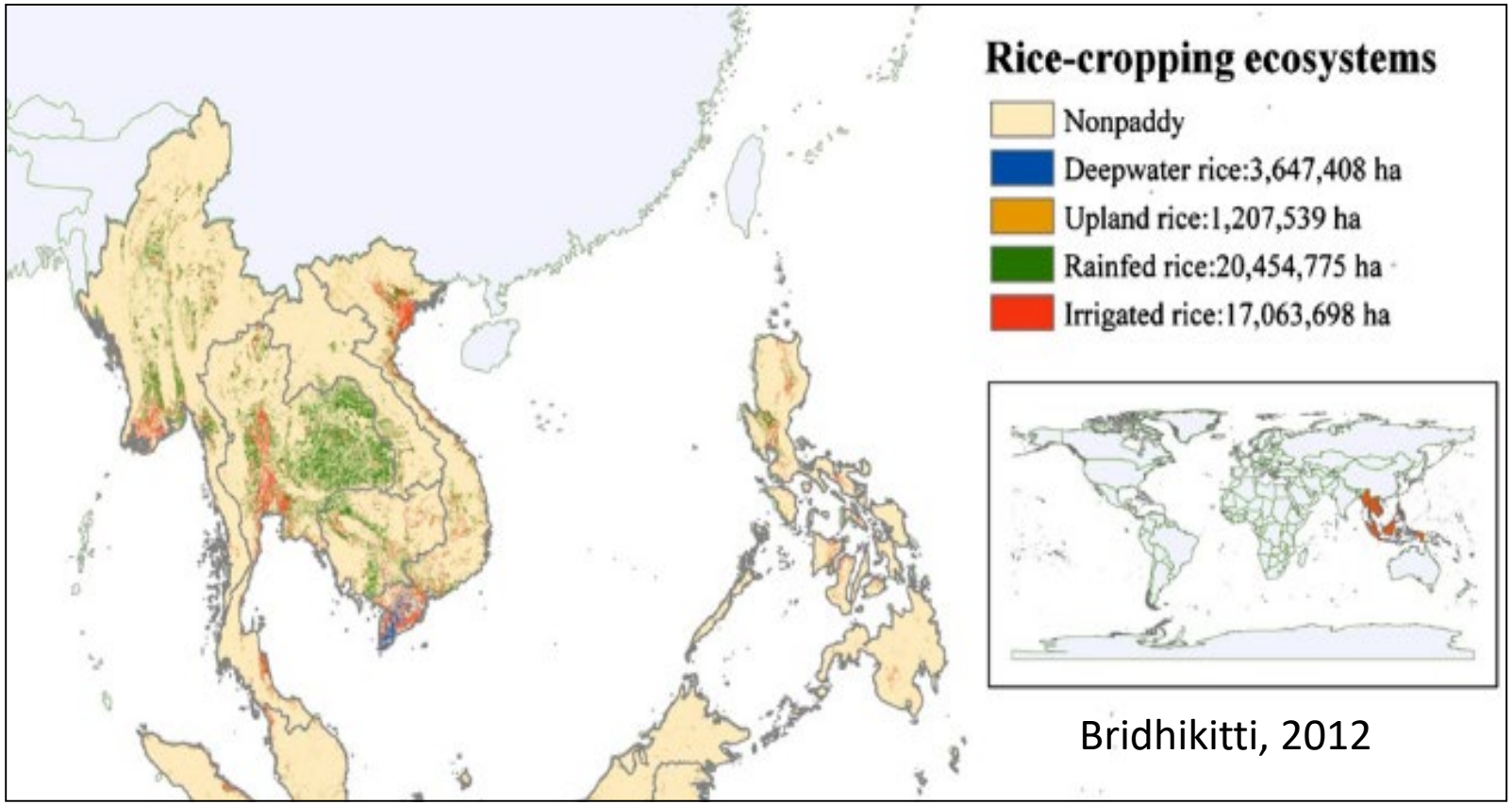
- Demonstrate in five countries in South-East Asia (Vietnam, Lao, Cambodia, Thailand, Myanmar)
- Update and maintain the GeoRice processing system in a cloud computing environment
- Make the GeoRice processing system available as open source

GeoRice

Big data, big challenges

Challenges:

1. Big data: from Mekong Delta to 5 countries in SE Asia
2. Diversity of rice cropping systems



Bridhikitti, 2012

GeoRice Diversity in rice ecosystems & cultural practices

Rice Varieties / Method of sowing

- **Long cycle**: **transplanting**

- **Short cycle**: **direct seeding**

Water management

1. Continuous flooding (CF):

5-12 cm during growing cycle

2. Alternate wetting and drying (AWD):

±5-10 cm at certain dates

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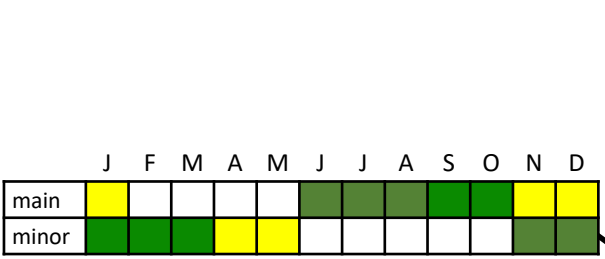
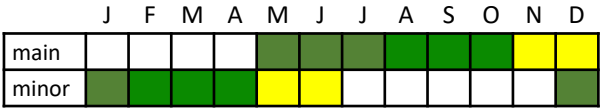
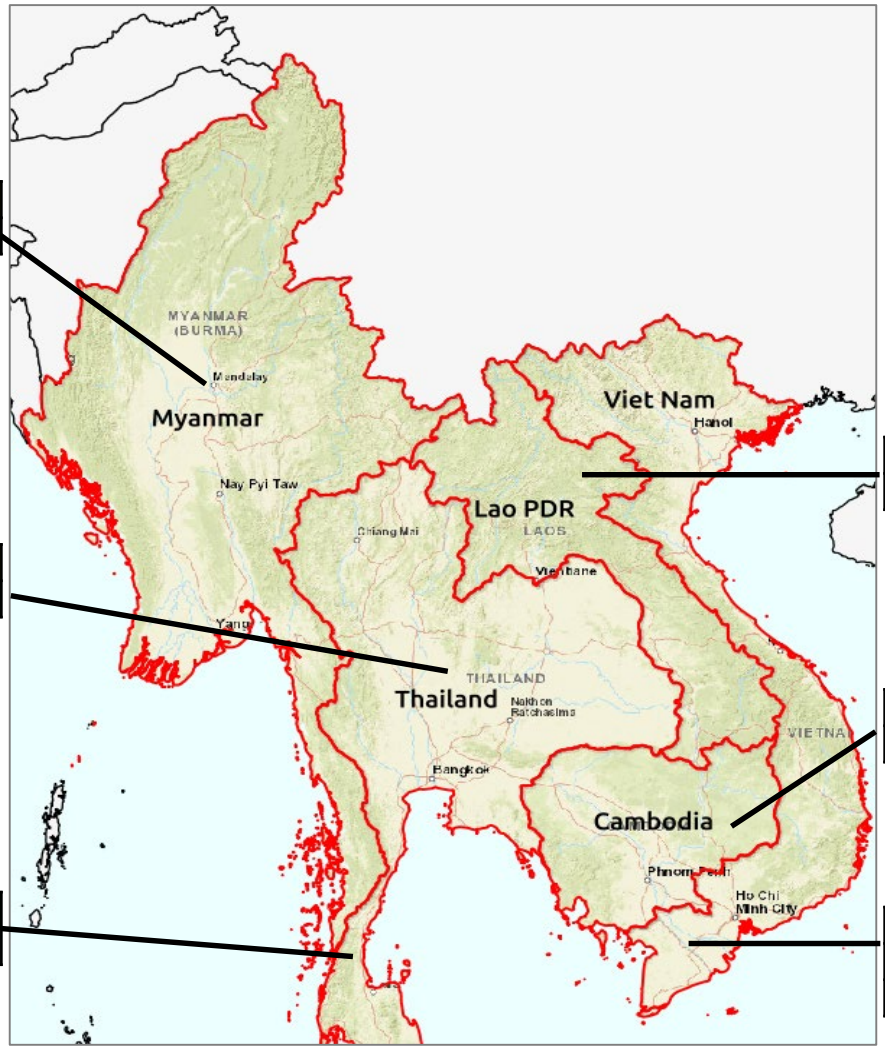
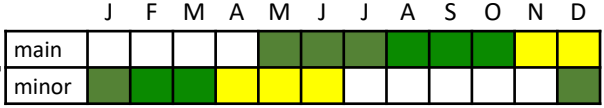
GeoRice

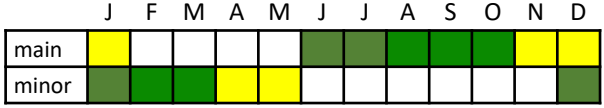
Diversity in crop calendar











Issues: Determination of the S1 time series period including the start and end of a rice season. Automation of the processes

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GeoRice

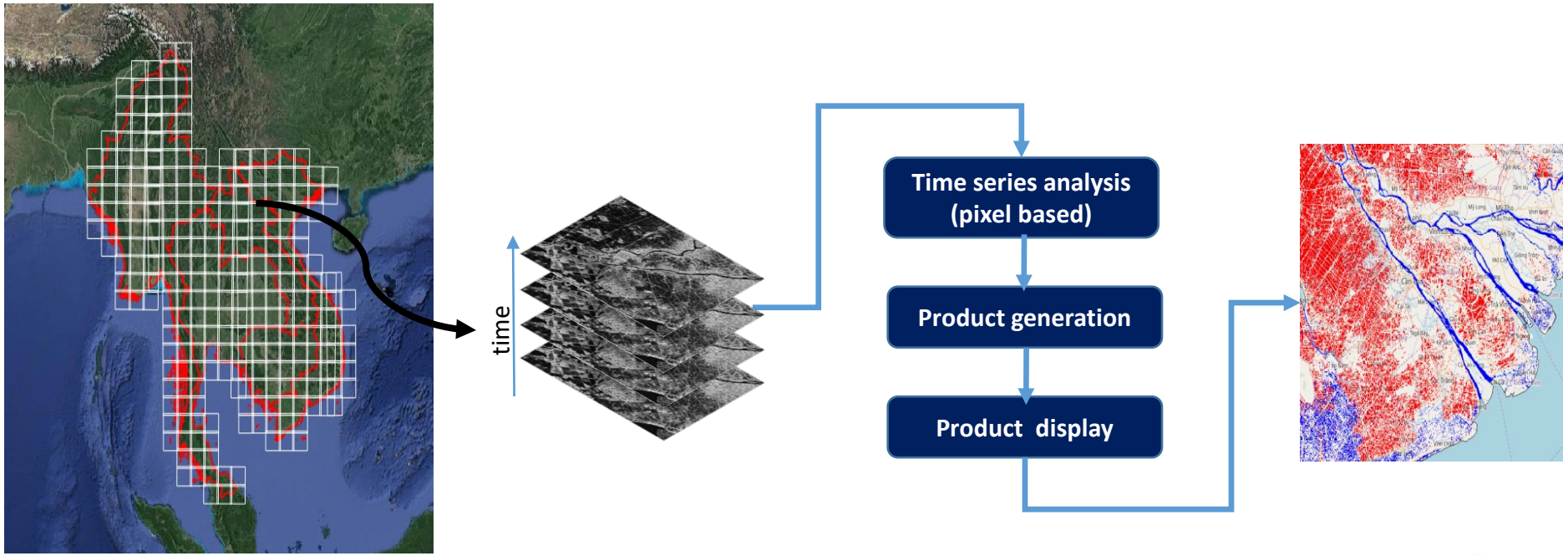
Processing architecture

Two major steps:

1. S1 data pre-processing

   Building the calibrated, orthorectified, speckle filtered time series over the area of interest (as in datacube)

2. Time series analysis (pixel-based) for product generation



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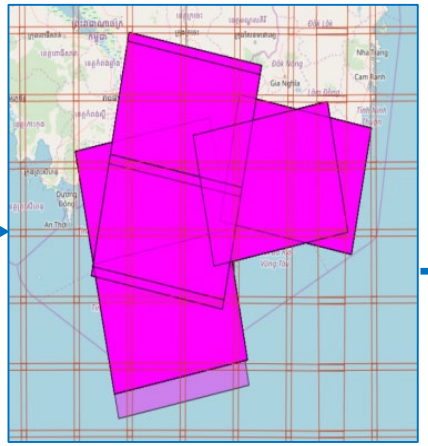
Data Preprocessing

S1 database

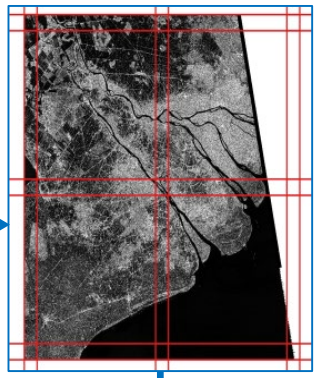
Data request

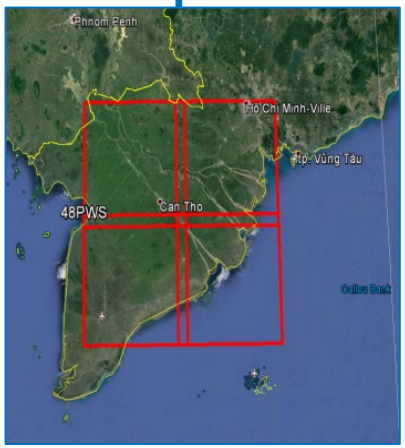
S1 GRD image dataset



Calibration, Projection, Concatenation

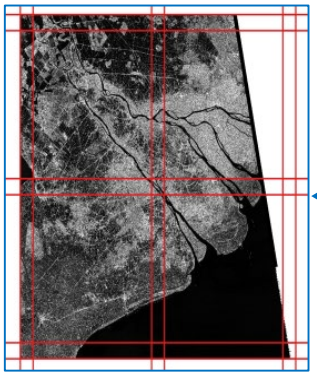
Projected Images





Region of interest

Filtered time series



Multi-image filtering

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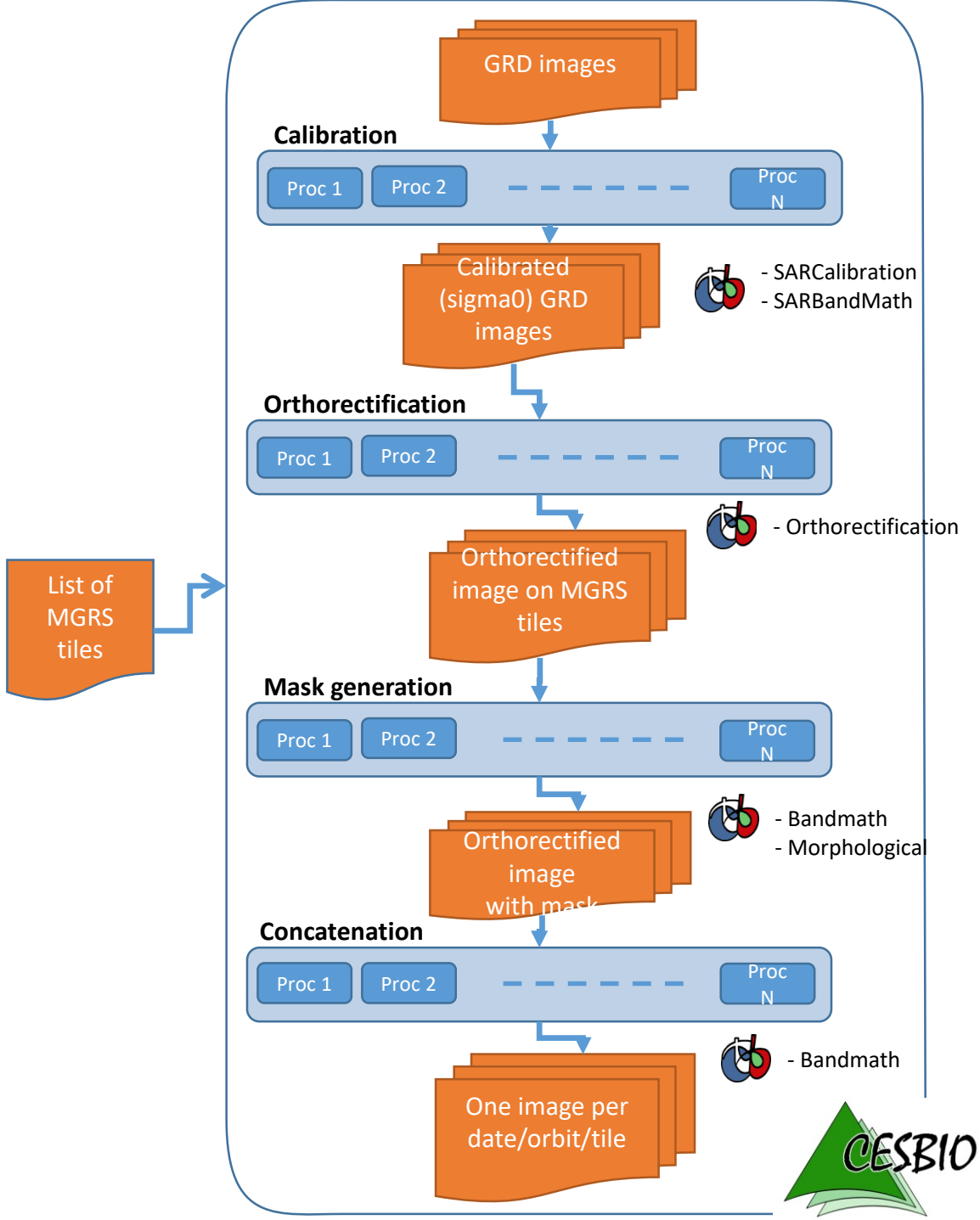
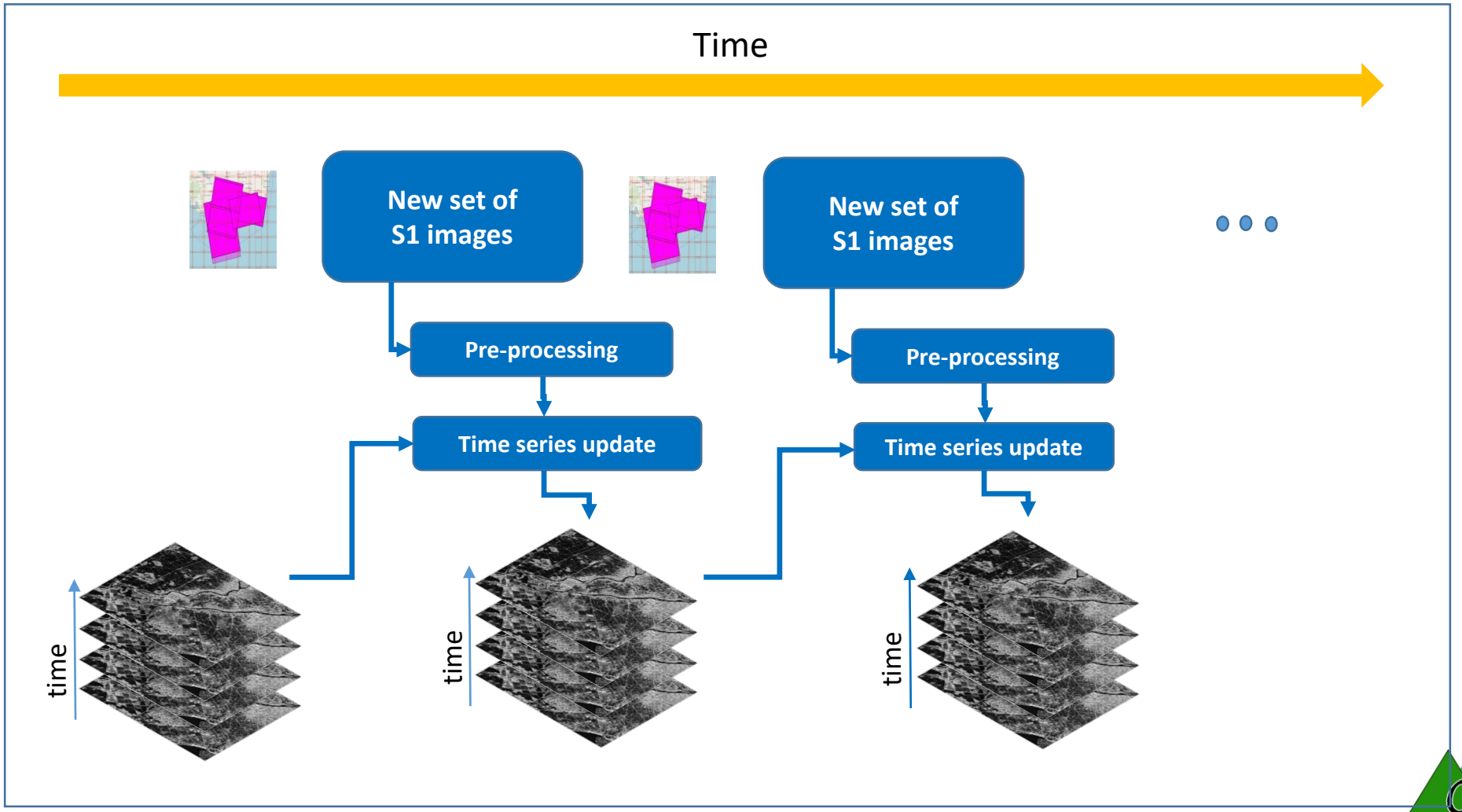
- Calibration
- Orthorectification with terrain correction
- Mask generation
- Images concatenation



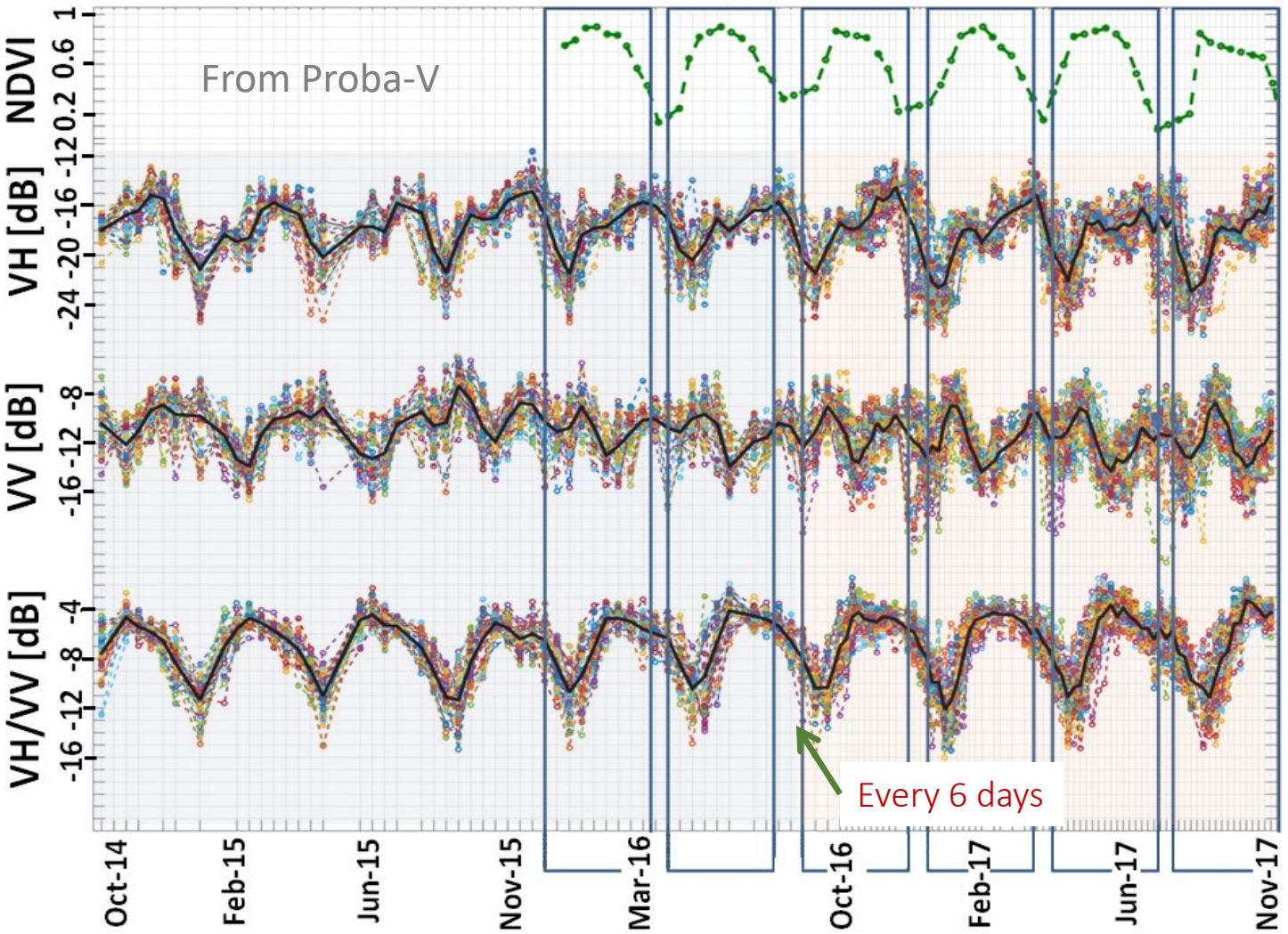
Building time series data

Building the calibrated, orthorectified, speckle filtered time series over the area of interest (as in datacube)



GeoRice

Time series analysis: irrigated rice



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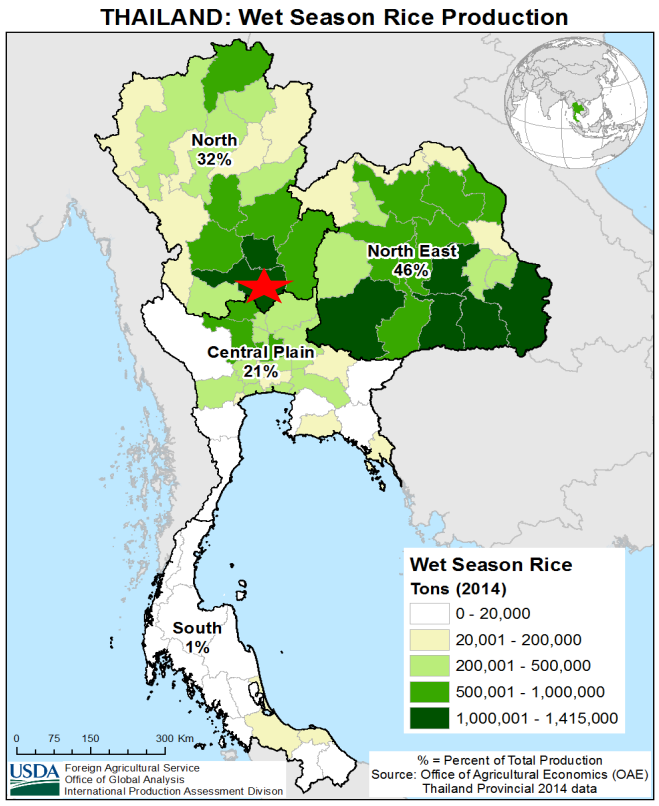
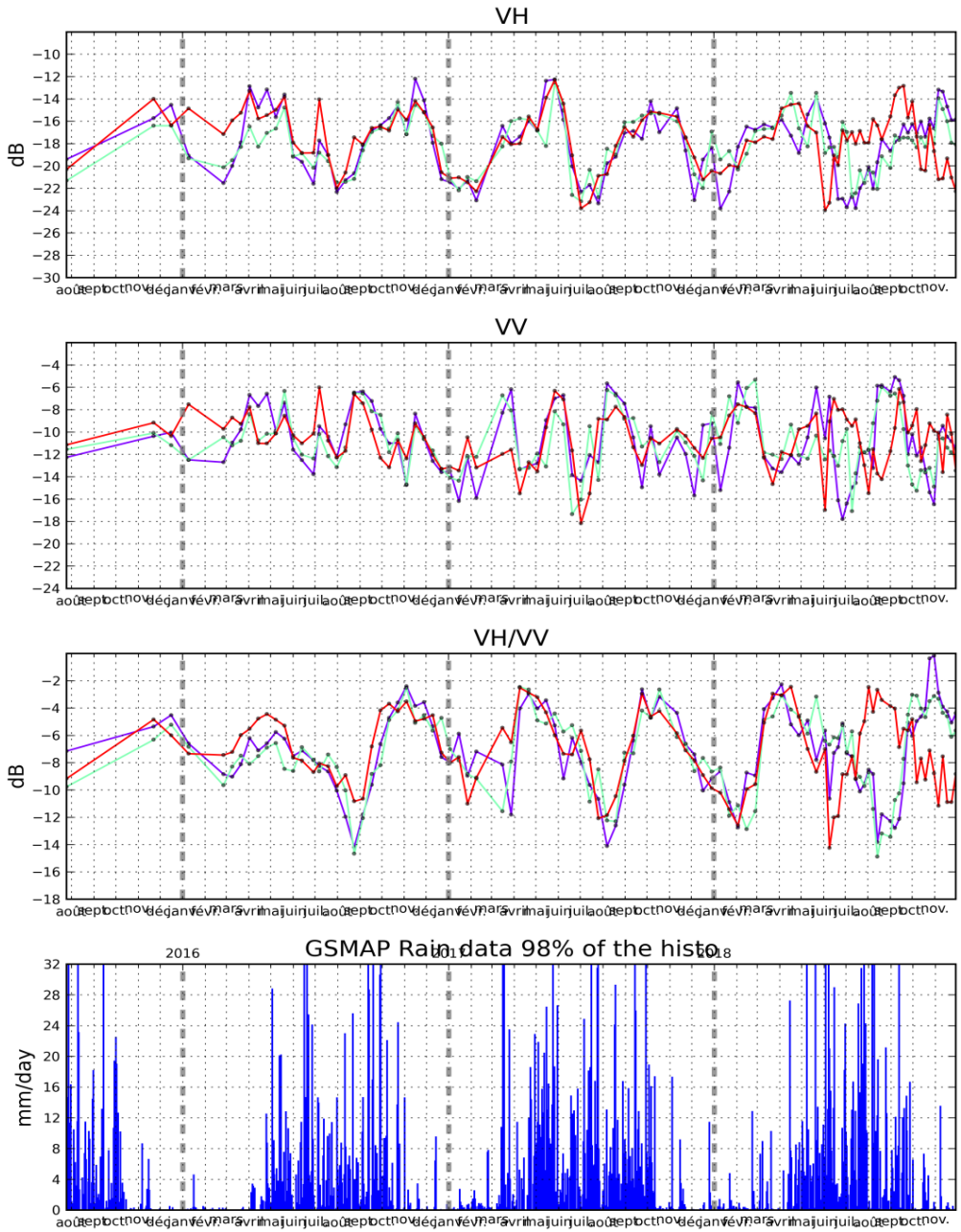
Irrigated Rice

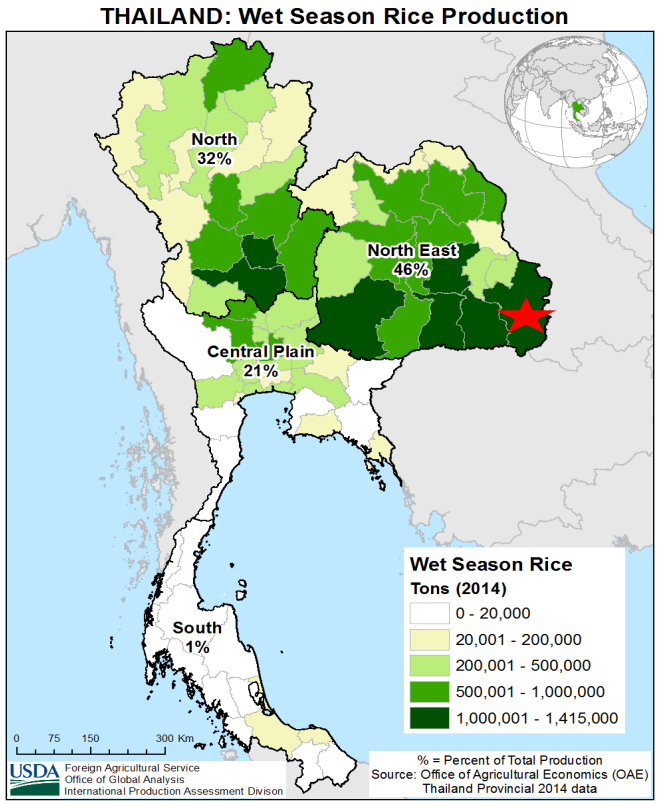


DESCENDING - 40°

Temporal variation of S1 over rice seasons - 47PPS
All field, 100 dates

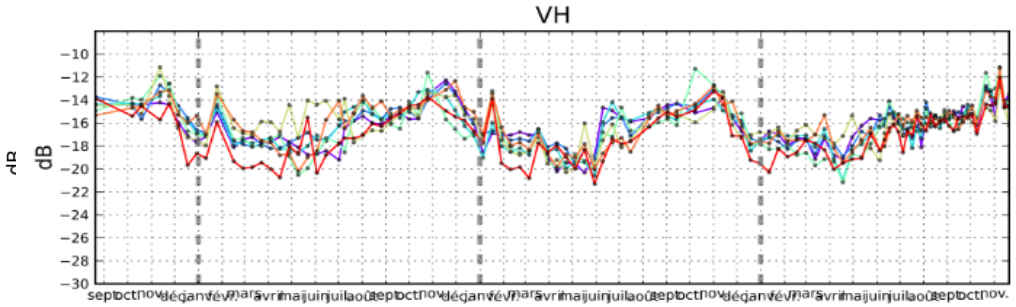


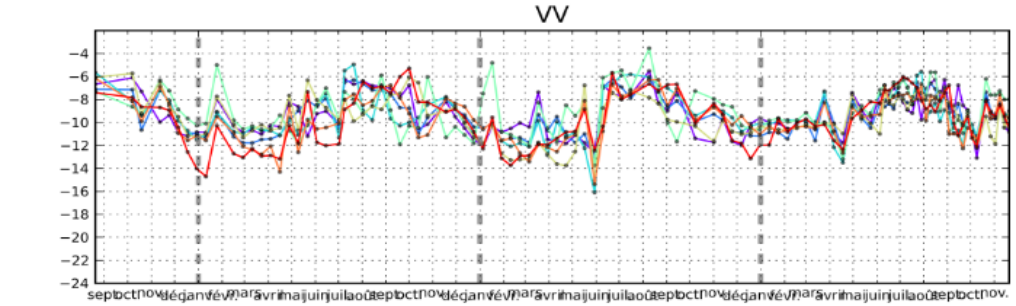
Rainfed Rice

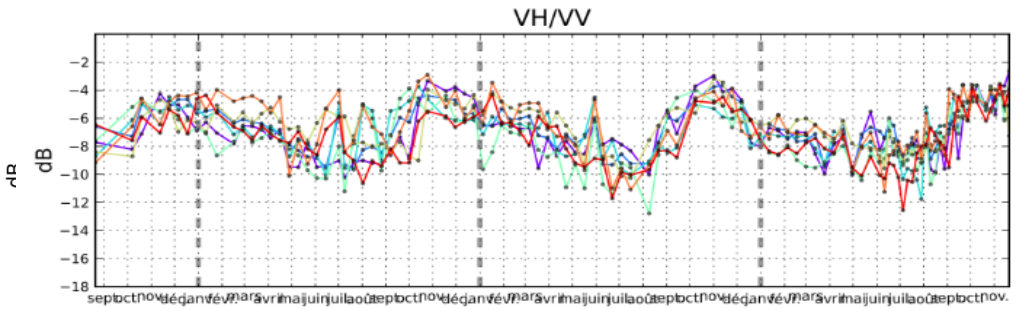


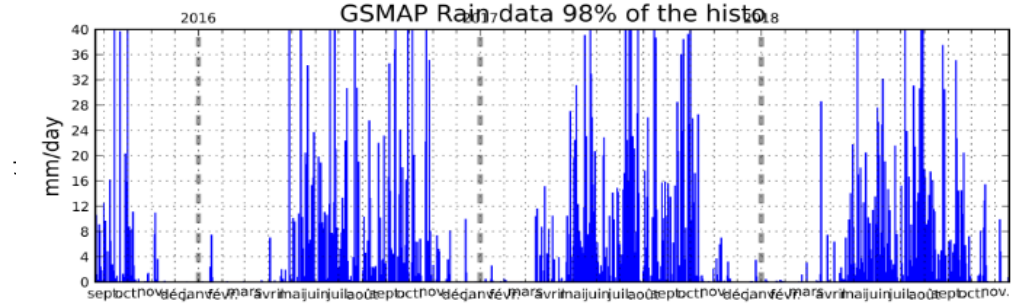
DESCENDING (34-35°)

Temporal variation of S1 over rice seasons - 48PWB
All field, 104 dates

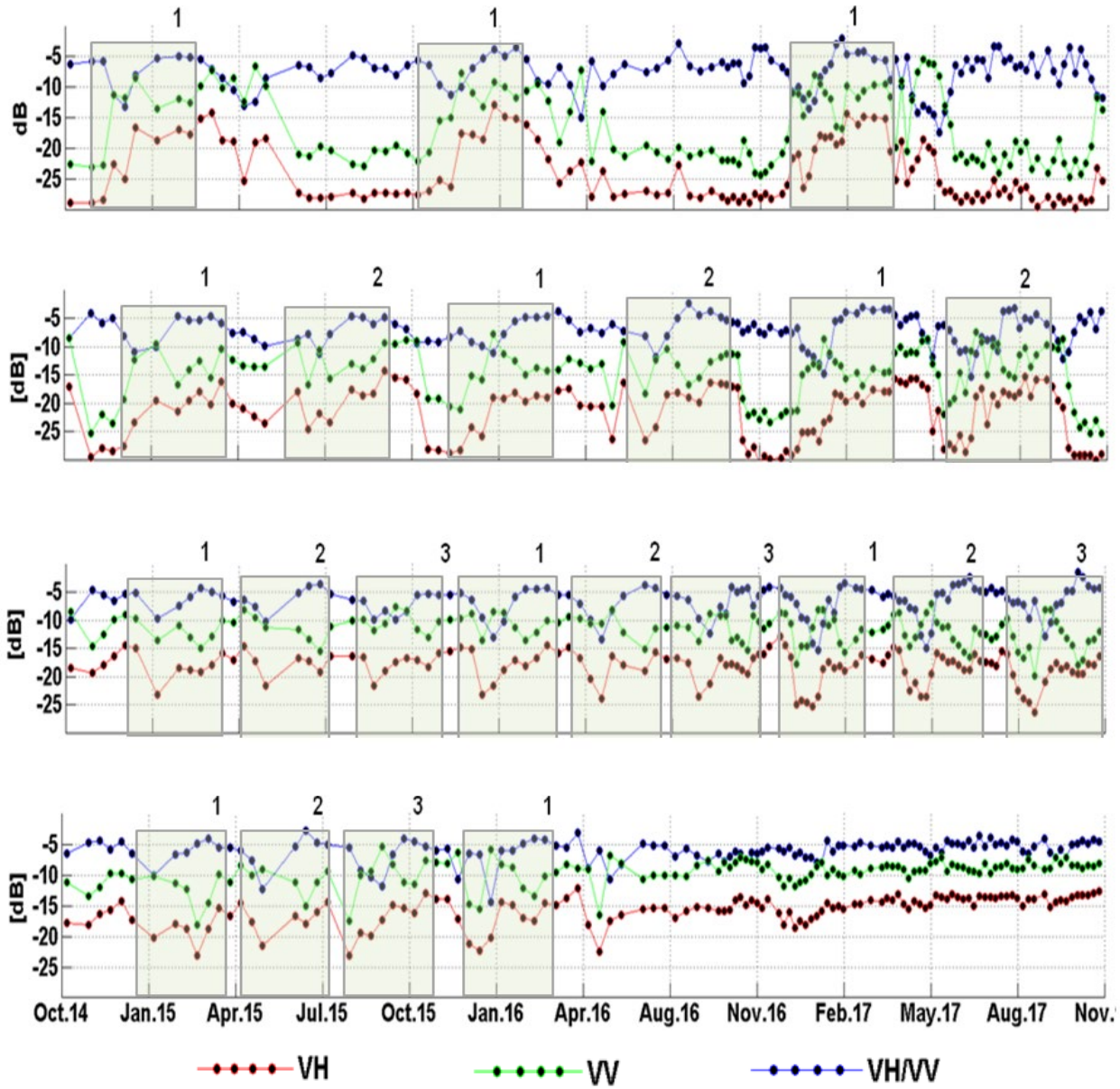








Time series analysis: cropping density



1 rice crop/year
(rice-shrimp)

2 rice crops/year
(rice-rice-vegetable)

3 rice crops/year

Change from rice
to other type

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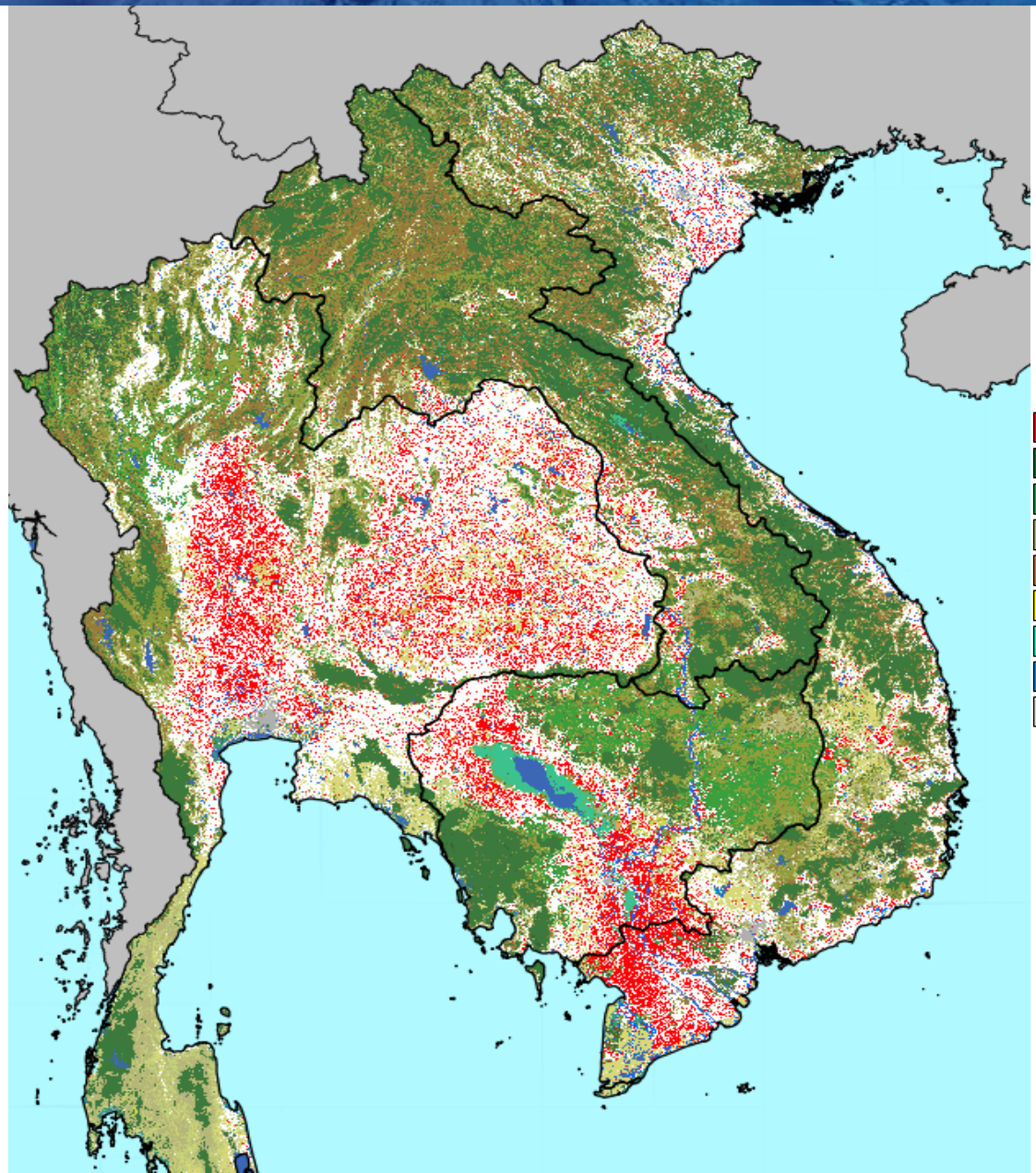
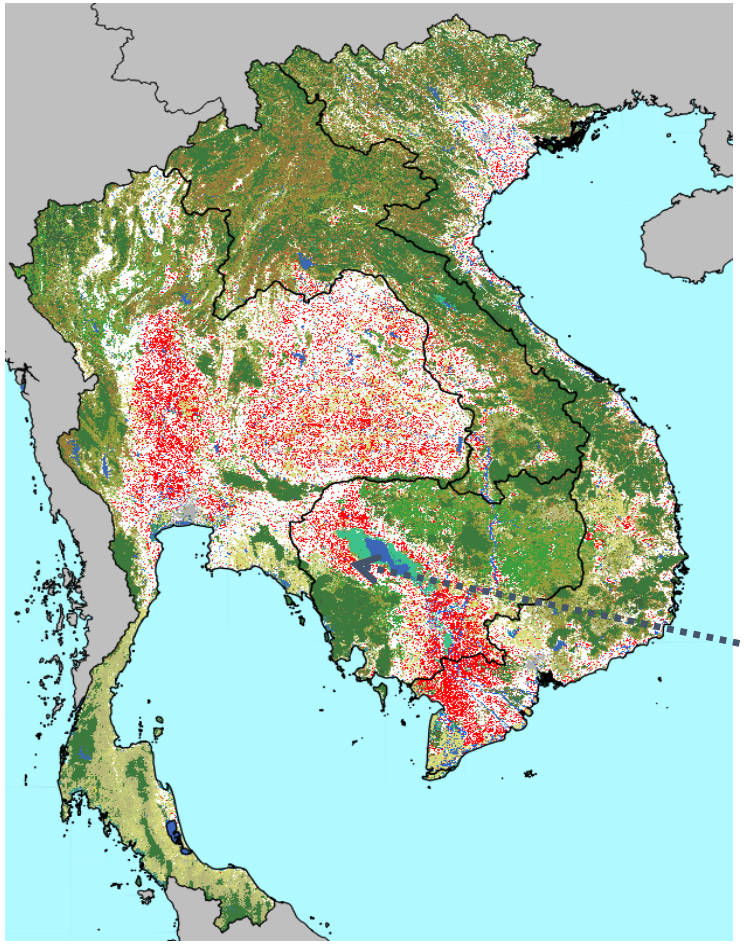
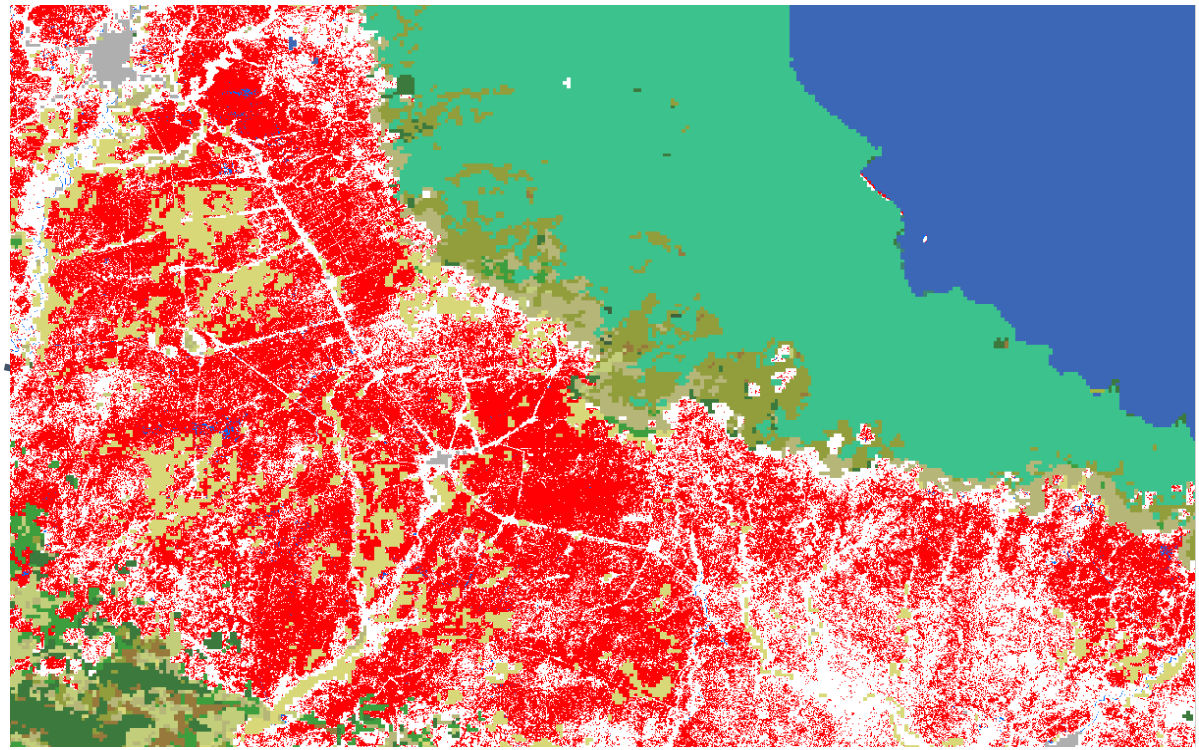
GEORICE first rice map covering 4 countries





- Rice
- Tree cover evergreen
- Tree cover Deciduous
- Mosaic tree schrubland
- Schrubland
- Cropland, herbaceous or schrub cover
- Flooded
- Inland water
- Urban/bare areas



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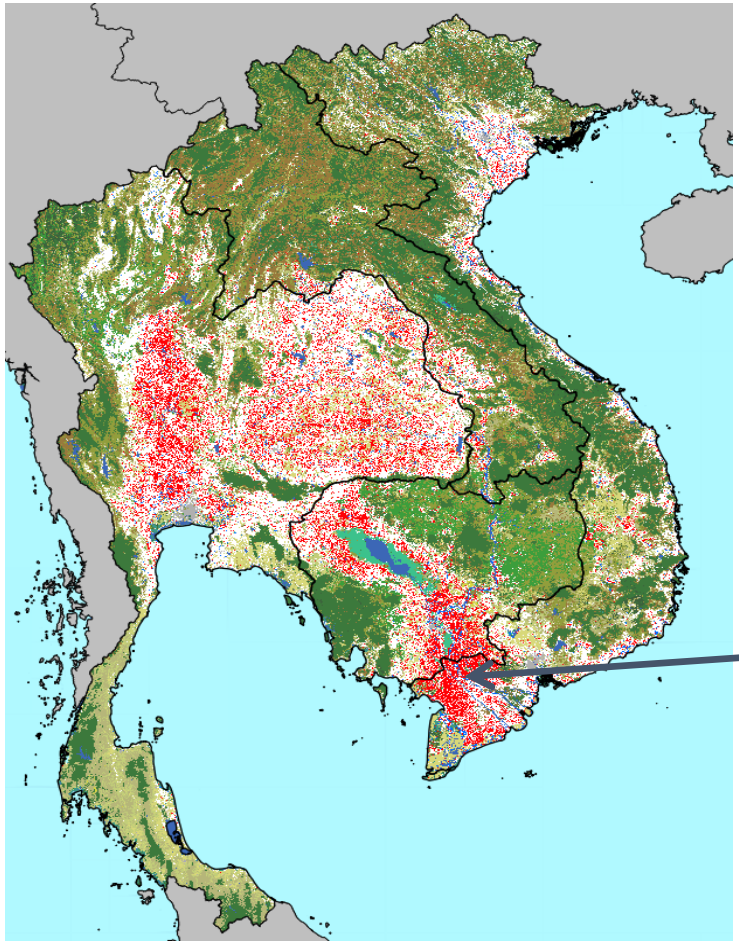

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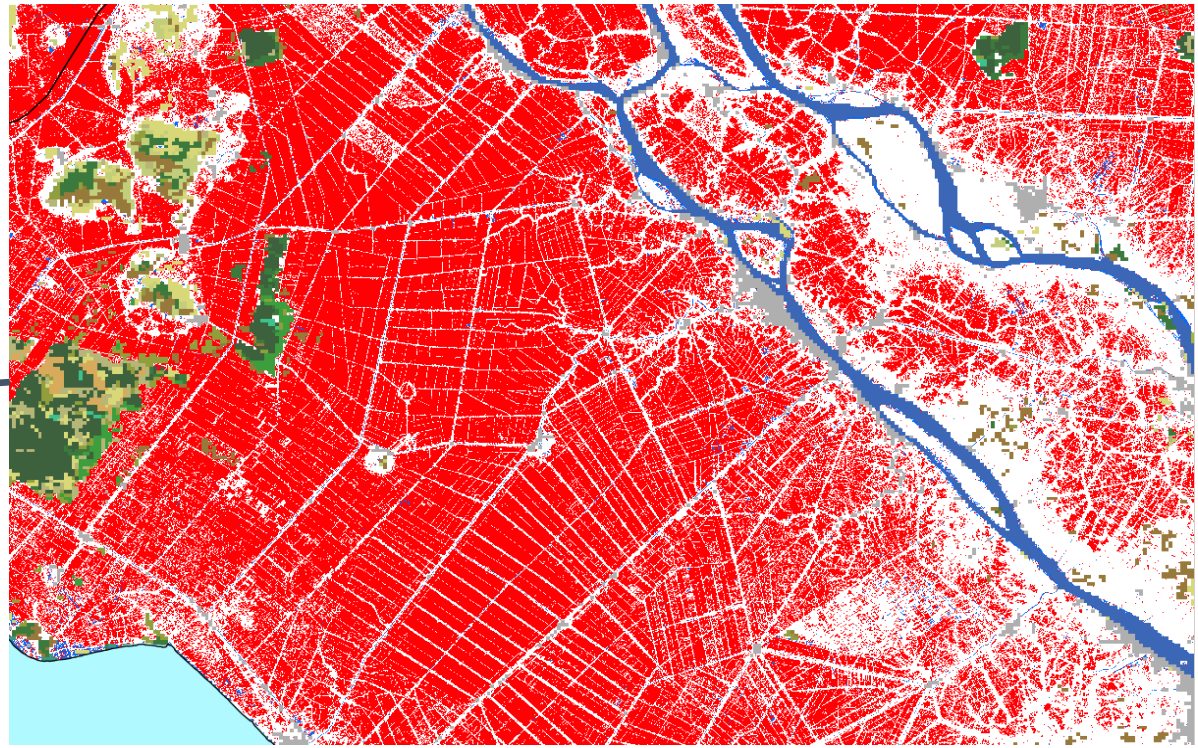

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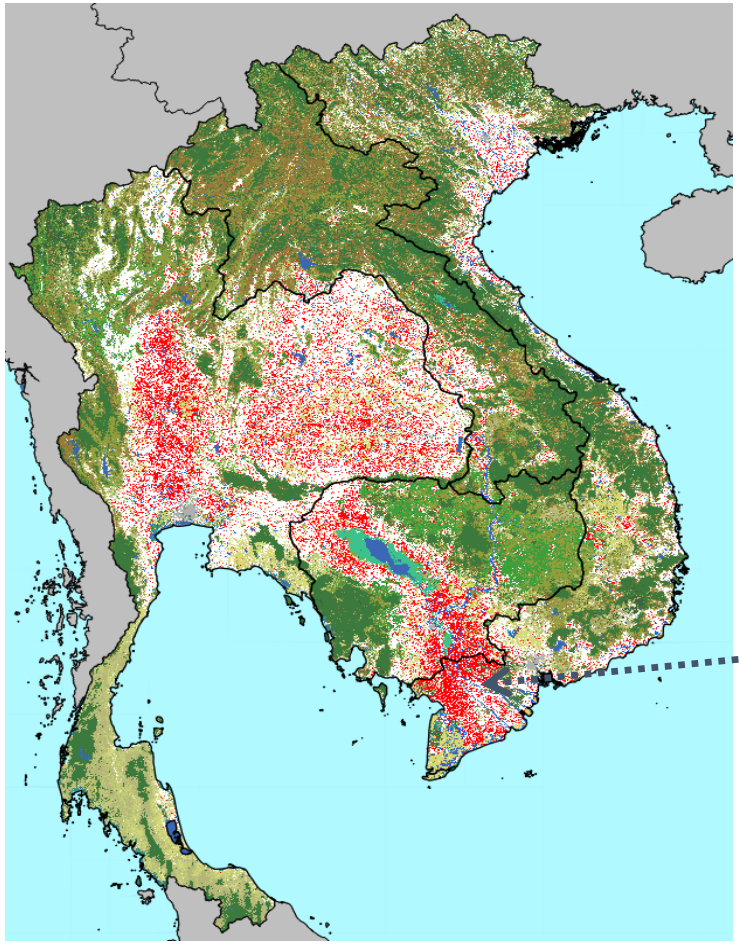

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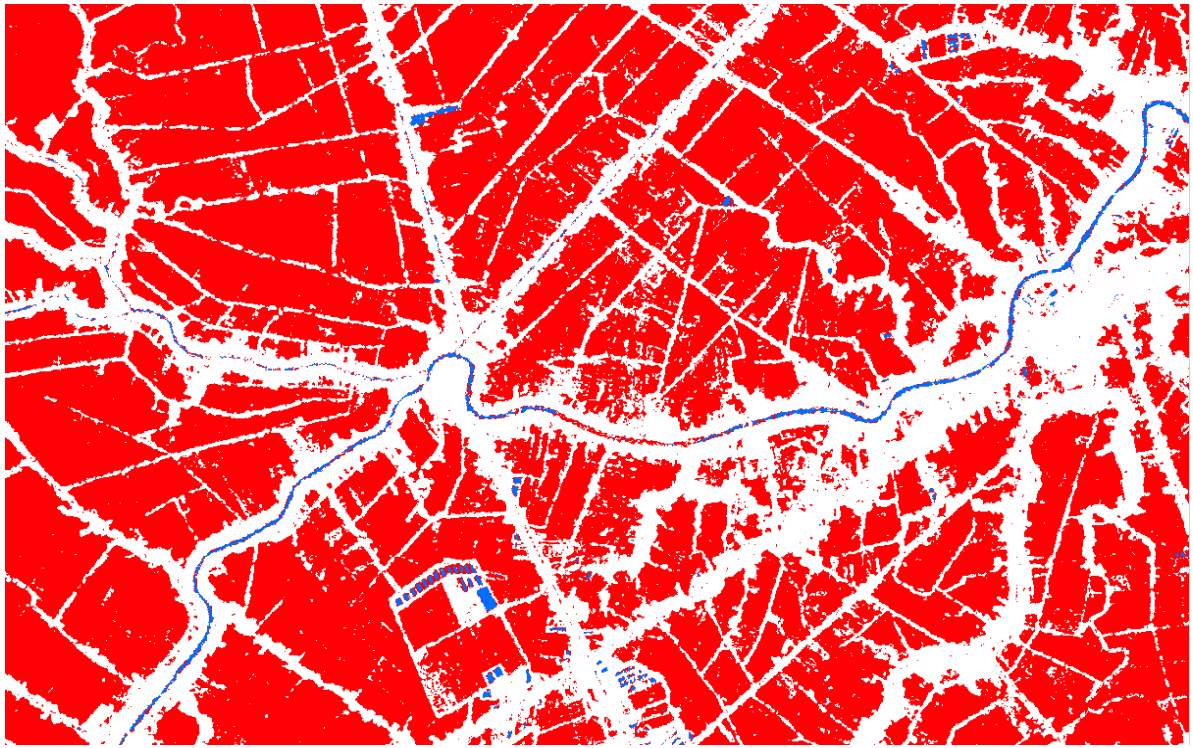

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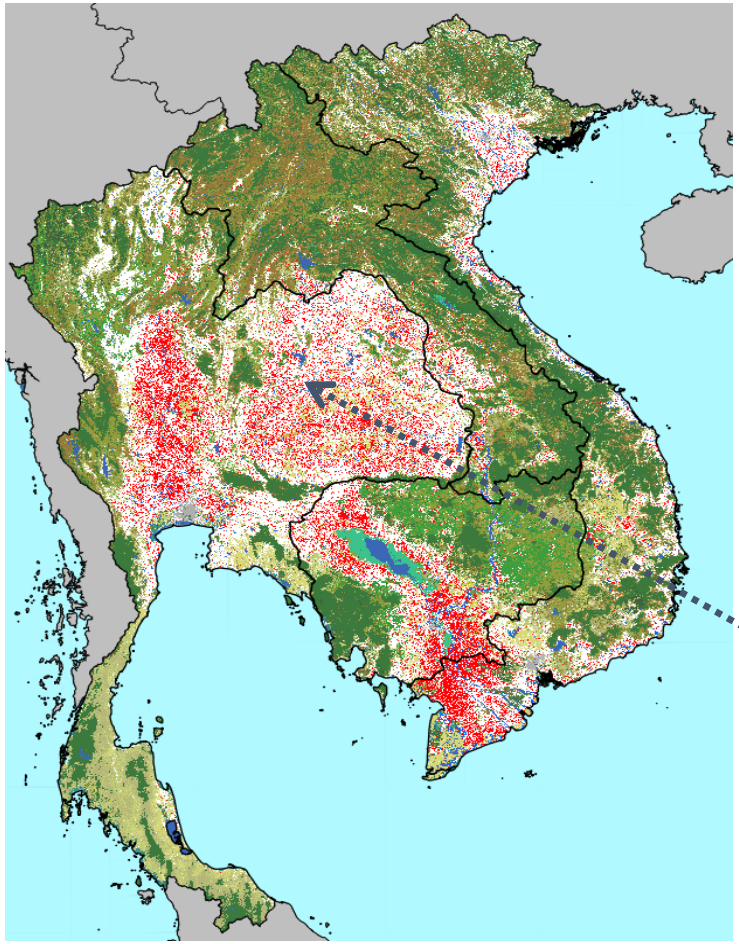

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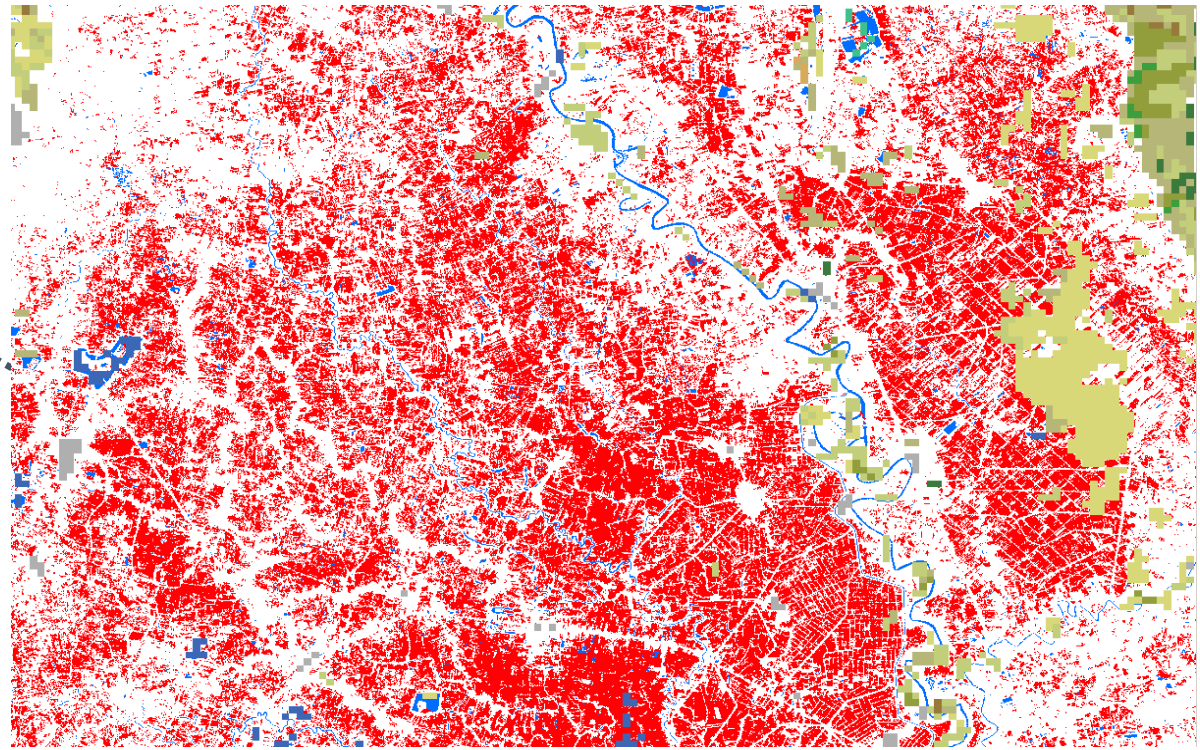

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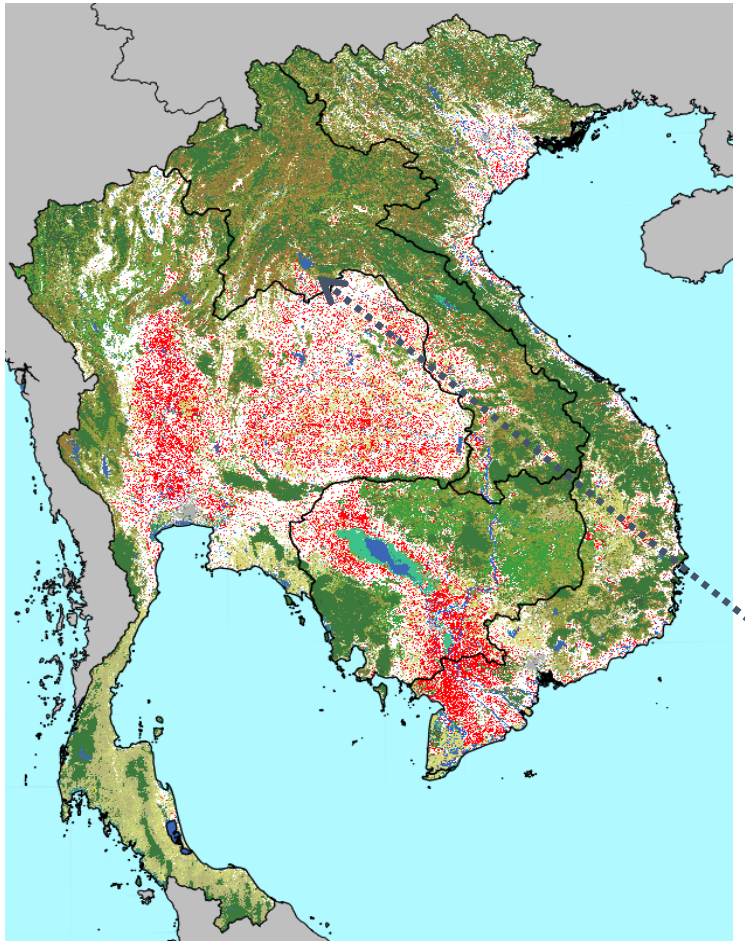
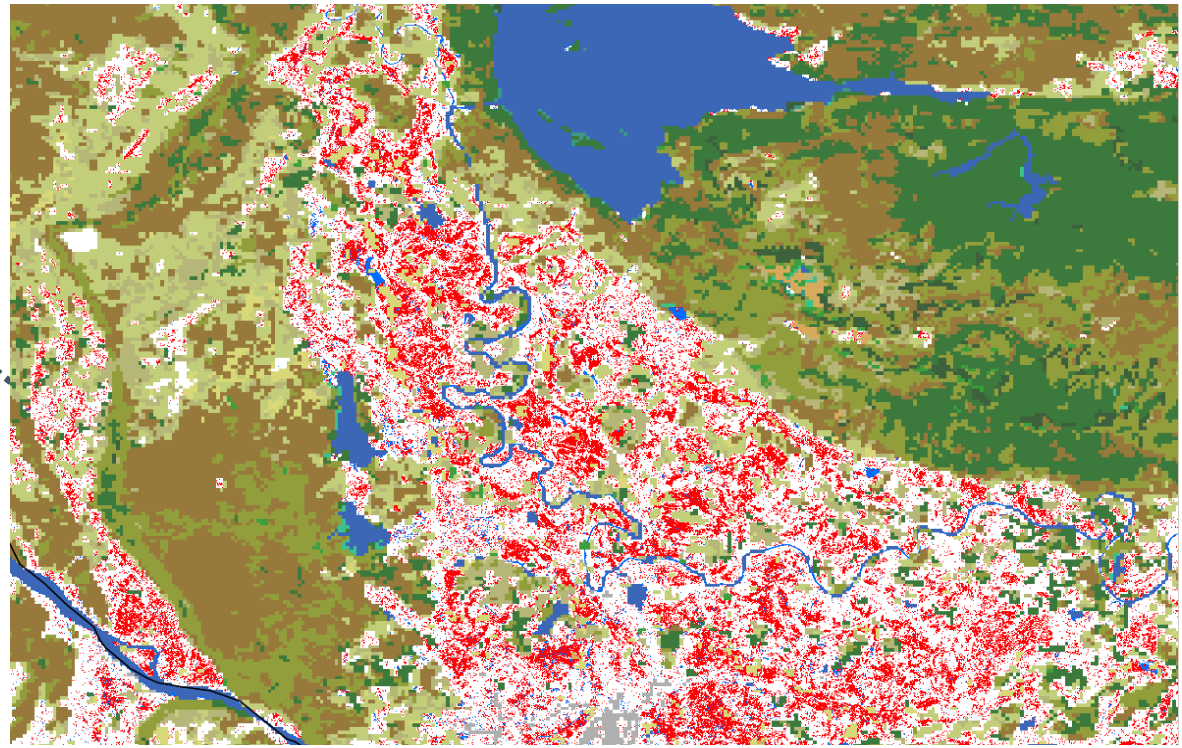


- Rice
- Tree cover evergreen
- Tree cover Deciduous
- Mosaic tree schrubland
- Schrubland
- Cropland, herbaceous or schrub cover
- Flooded
- Inland water
- Urban/bare areas

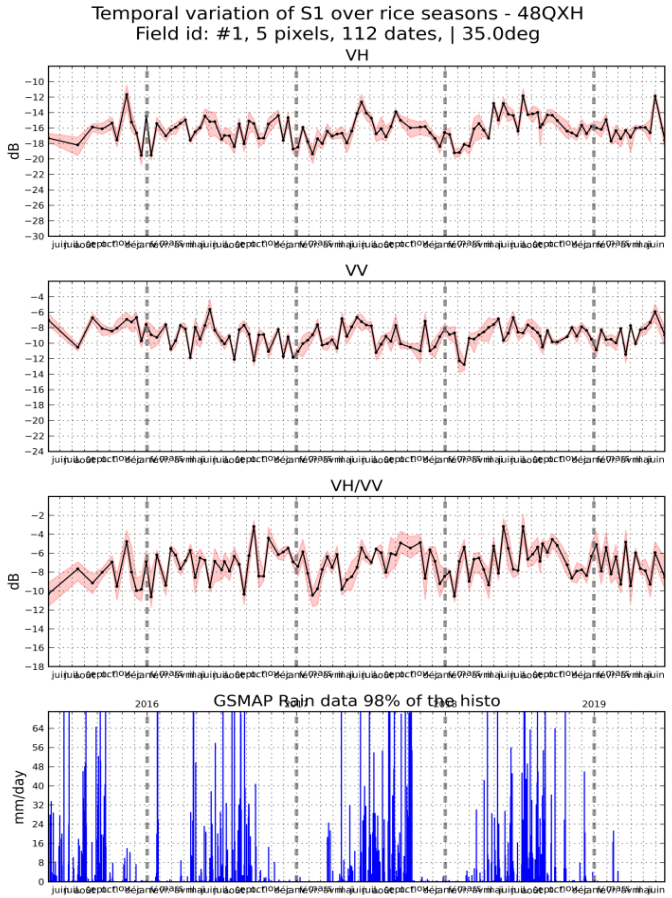


CESBIO

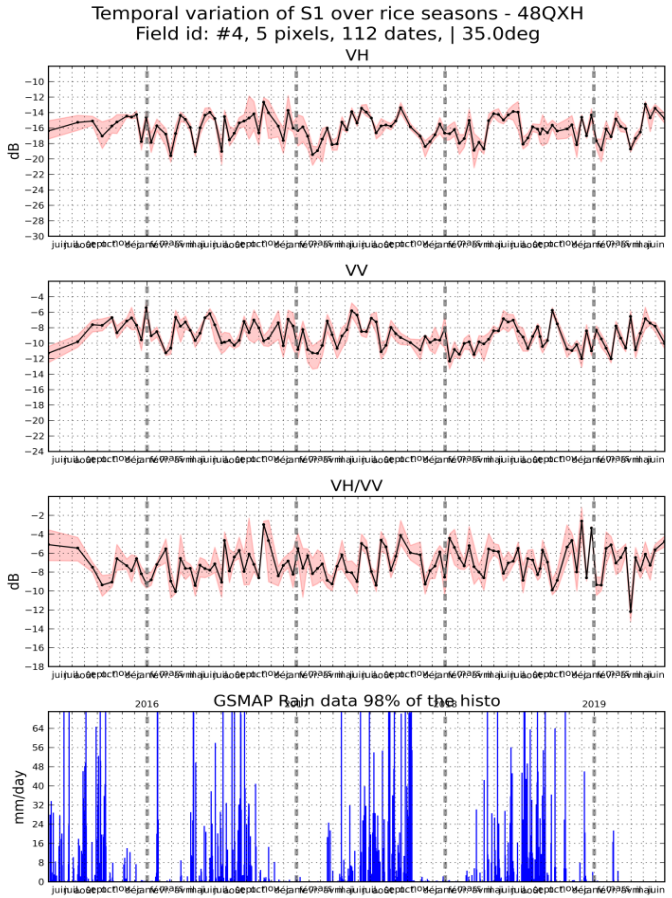
GeoRice Project status and further works

- High resolution rice mapping at large scale in SE Asia demonstrated
  Result validation on going
- Rice growth status every 12 days: big challenges at large scale
  Possible regional solutions by rice ecosystems
- Contact with effective users to be consolidated

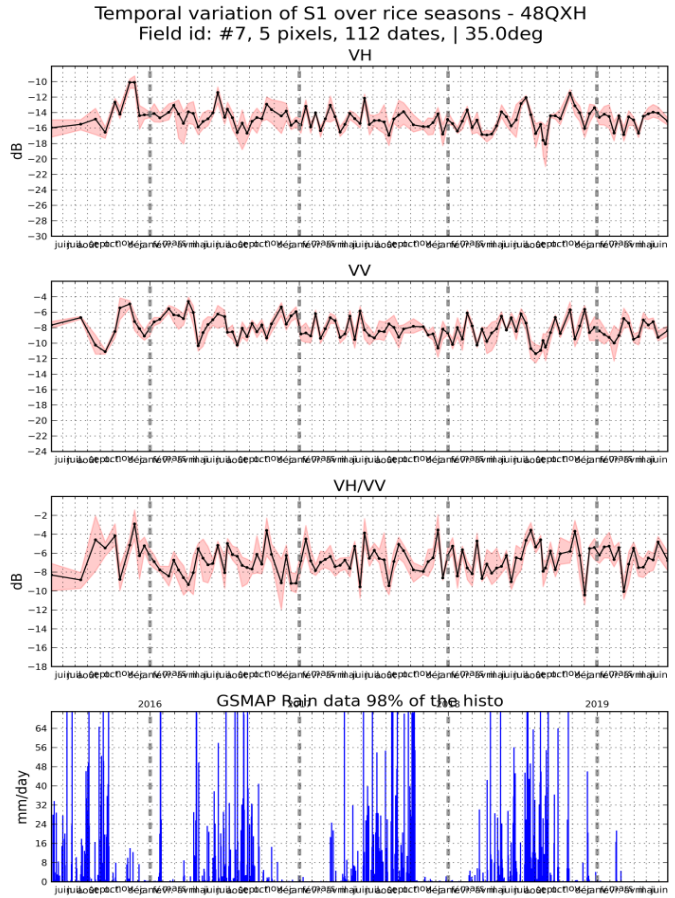
Bokchoy


Temporal variation of S1 over rice seasons - 48QXH
Field id: #1, 5 pixels, 112 dates, | 35.0deg
VH
dB
VV
VH/VV
dB
GSMAP Rain data 98% of the histo
2016
2019
mm/day

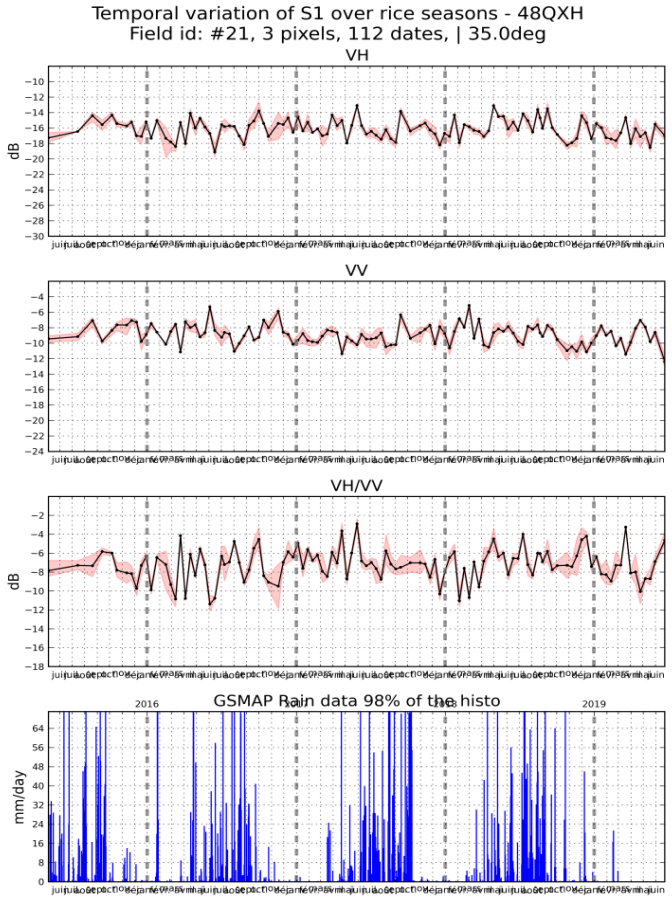
Cabbage


Temporal variation of S1 over rice seasons - 48QXH
Field id: #4, 5 pixels, 112 dates, | 35.0deg
VH
VV
VH/VV
dB
GSMAP Rain data 98% of the histo
2016
2019
mm/day

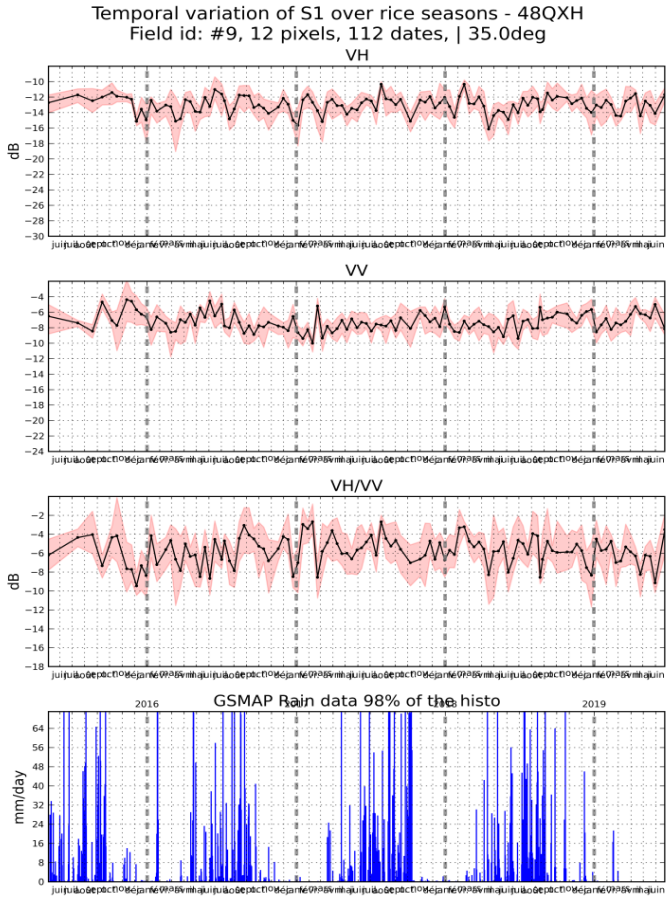
Eggplant


Temporal variation of S1 over rice seasons - 48QXH
Field id: #7, 5 pixels, 112 dates, | 35.0deg
VH
dB
VV
VH/VV
dB
GSMAP Rain data 98% of the histo
2016
2019
mm/day

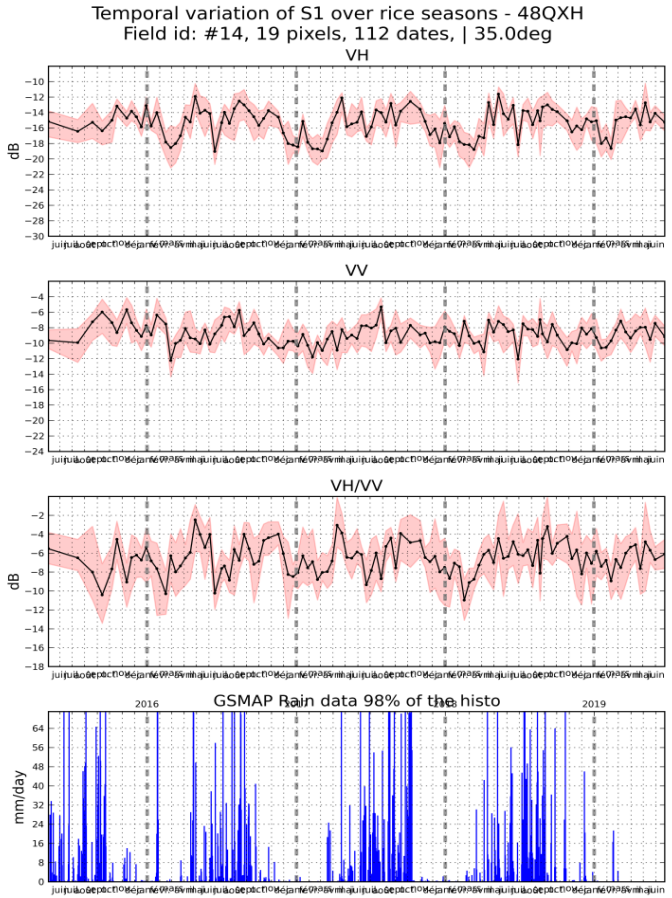
Choysum


Temporal variation of S1 over rice seasons - 48QXH
Field id: #21, 3 pixels, 112 dates, | 35.0deg
VH
VV
VH/VV
dB
GSMAP Rain data 98% of the histo
2016
2019
mm/day

Morningglory



corn


Temporal variation of S1 over rice seasons - 48QXH
Field id: #14, 19 pixels, 112 dates, | 35.0deg
VH
dB
VV
VH/VV
dB
GSMAP Rain data 98% of the histo
2016
2019
mm/day