GEOGLAM
Global Agricultural Monitoring

Asia-RiCE
Crop Estimation and Monitoring

On behalf of Asia-RiCE team

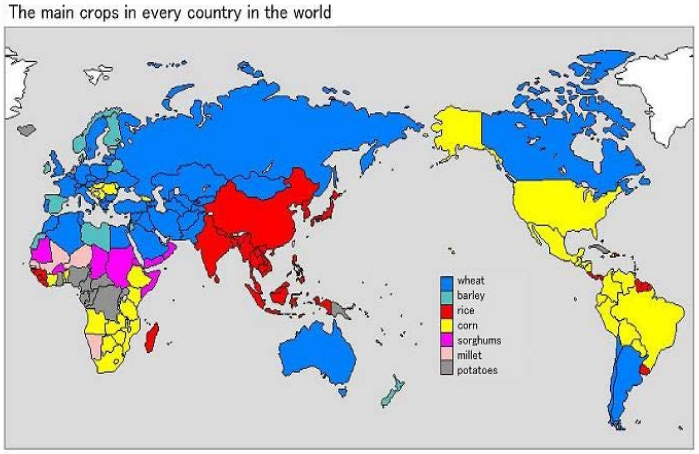
Thuy Le Toan, Shin-Ichi Sobue and Kei Oyoshi

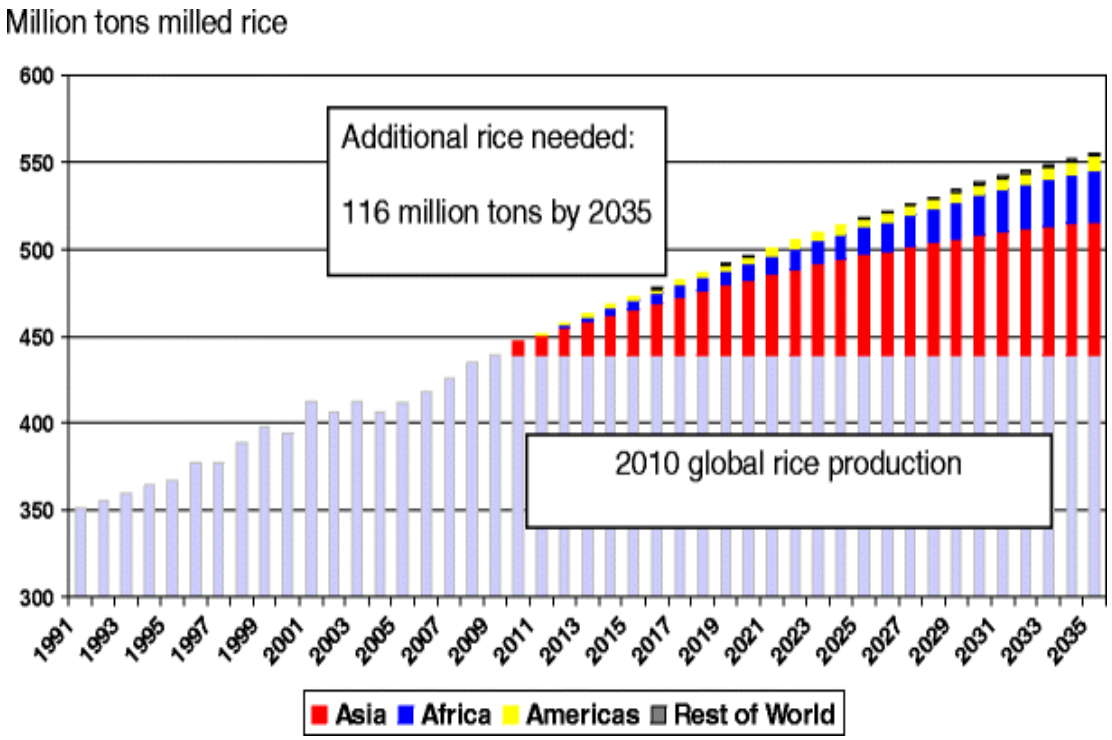
GEOSS-AP@Kyoto

General background

Rice food demand is increasing

- Rice food demand continues to increase due to rapid population growth
- In Asia, where rice is the main crop , about additional 80 million tons will be needed in 2035 compared to 2010



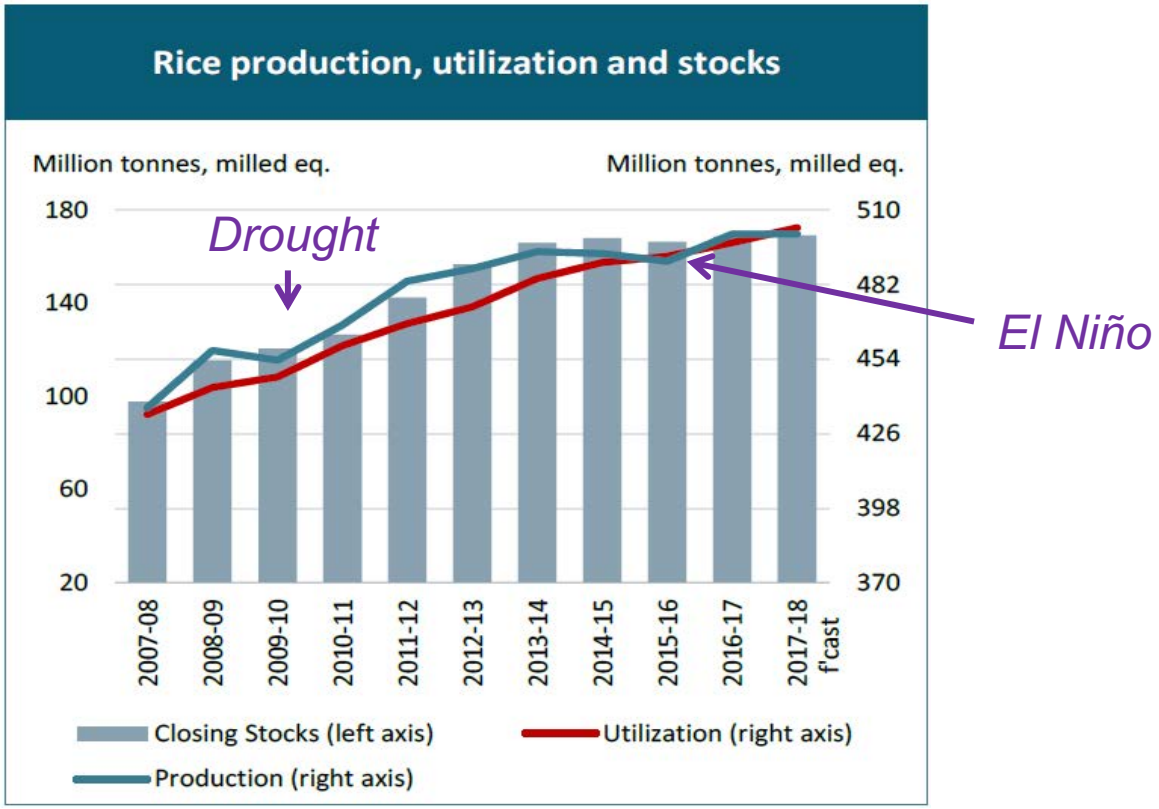


Rice production affected by climate change

- Increase of Rice production to meet the demand is threatened by adverse weather (flood and drought) under global warming

→ Fluctuation in rice production

→ No increase in the rice stocks in the past 5 years



Early rice production information is required for food security

Crop production= crop grown area x number of crop seasons per year x crop yield per season

Earth Observation is expected to provide timely and synoptic information on:

- crop grown area, for estimating rice grown area, the number of crops per year

- crop phenological stage, growth anomaly .. for early warning and for estimating the rice yield

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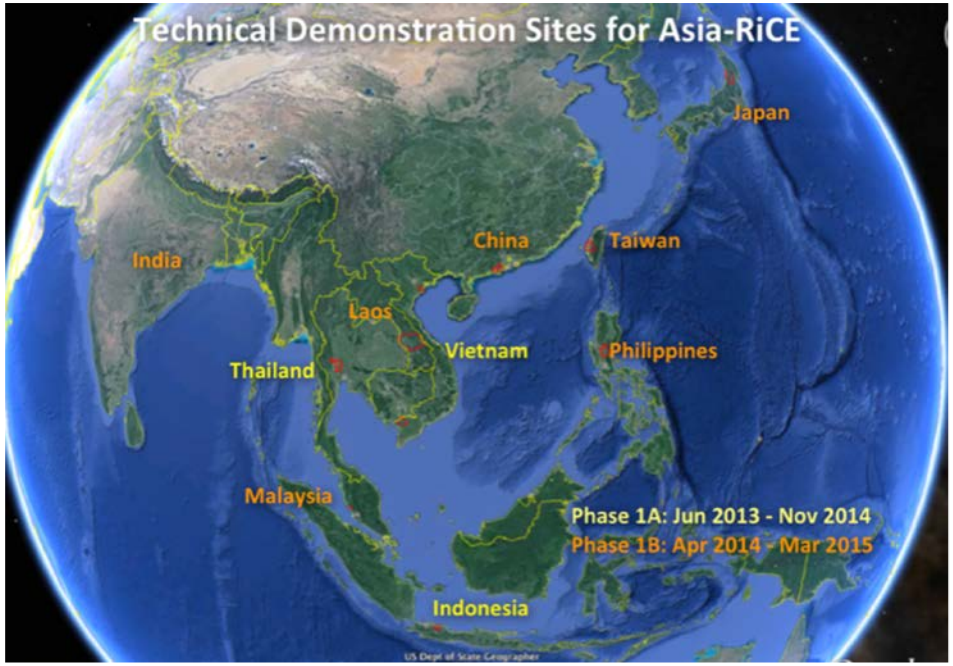
Asia-RiCE (Asia Rice Crop Estimation & Monitoring) program led by JAXA with CNES and more than 20 Asian Space Agencies and Ministries of Agriculture with International organizations such as ASEAN/AFSIS, UN/FAO, IRRI .

POC: Sobue.shinichi@jaxa.jp, ohyoshi.kei@jaxa.jp, Thuy.Letoan@cesbio.cnes.fr



Asia-RiCE Website: http://www.asia-rice.org

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Rice Crop Mapping in Southeast Asia

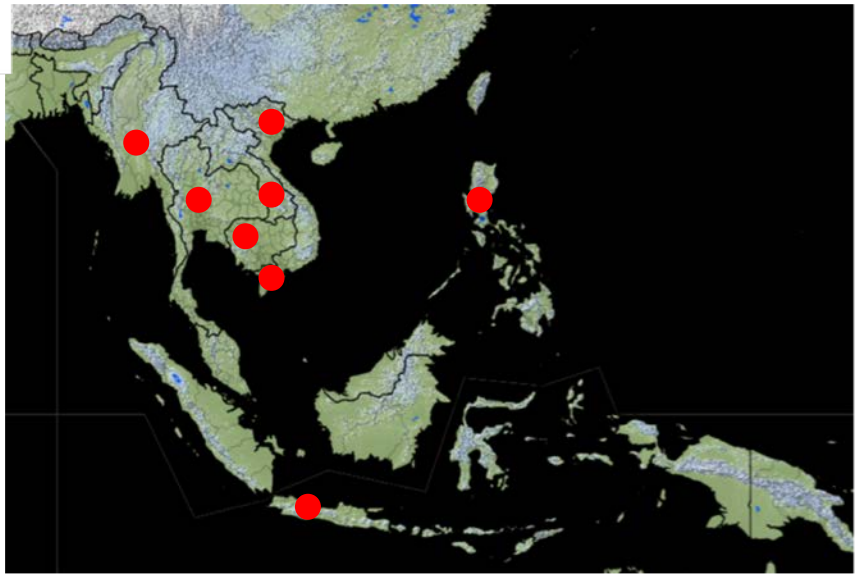
- ADB Technical Assistance project and SAFE project under the APRSAF have successfully demonstrated INAHOR using ALOS-2 with the mapping accuracy of 80-90% for the target provinces
- Scaling-up for major rice producing areas is currently demonstrated in Vietnam and Indonesia.

ADB | Japan Fund for Poverty Reduction | From the People of Japan

ADB TA Project

- Laos
- Thailand
- Vietnam (North)
- Philippines

[2014-2016]



SAFE

SAFE Project (Test site)

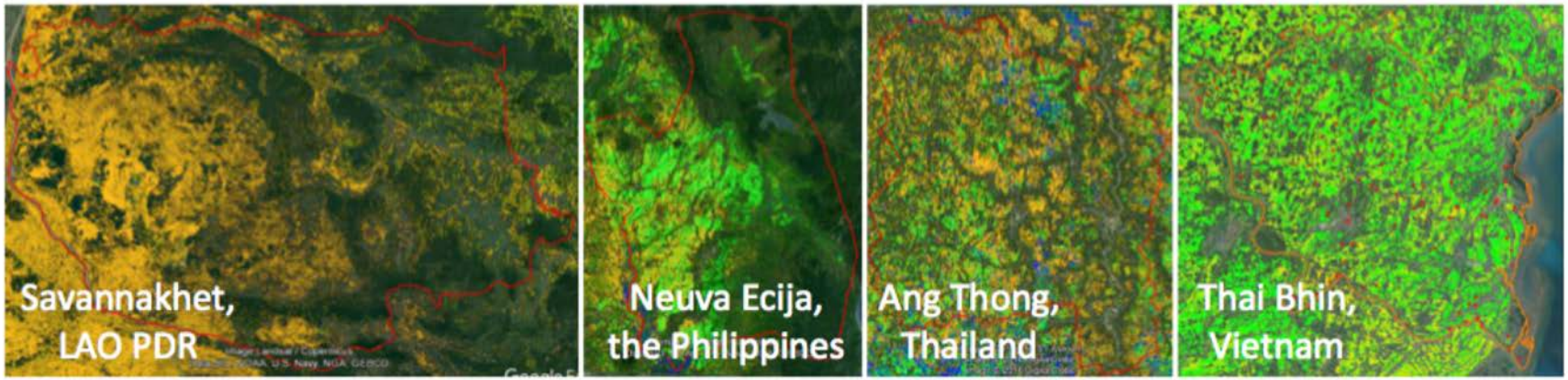
- Myanmar
- Cambodia

[2016-]

SAFE Project (Scaling-up)

- Vietnam (Mekong Delta)
- Indonesia

[2014-]



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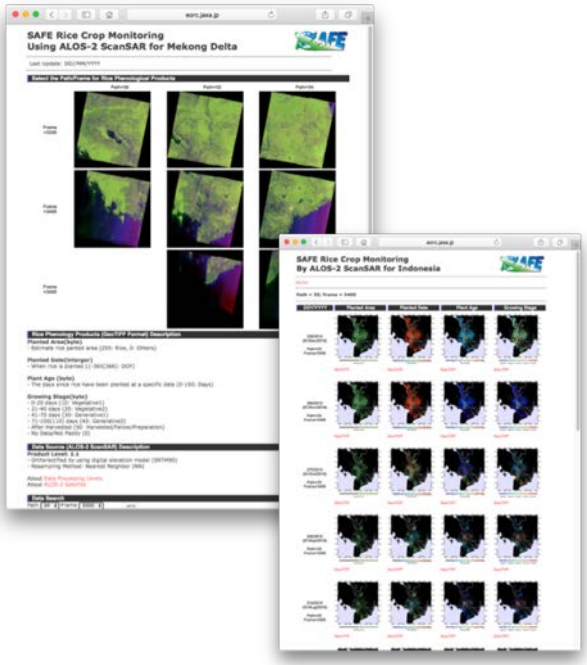
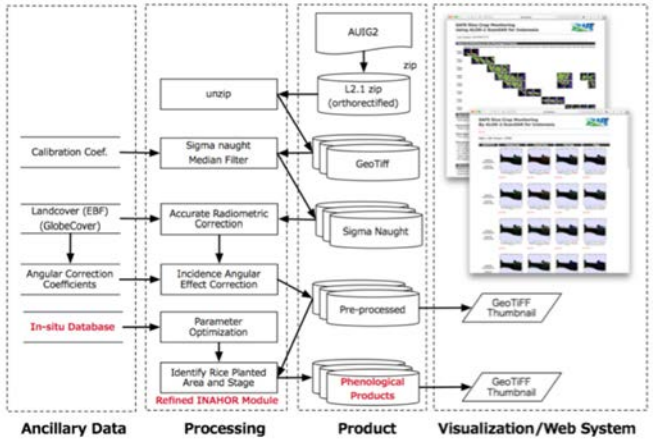
Rice Crop Monitoring System for Scaling-up

Indonesia

Mekong Delta



Data Processing Flow



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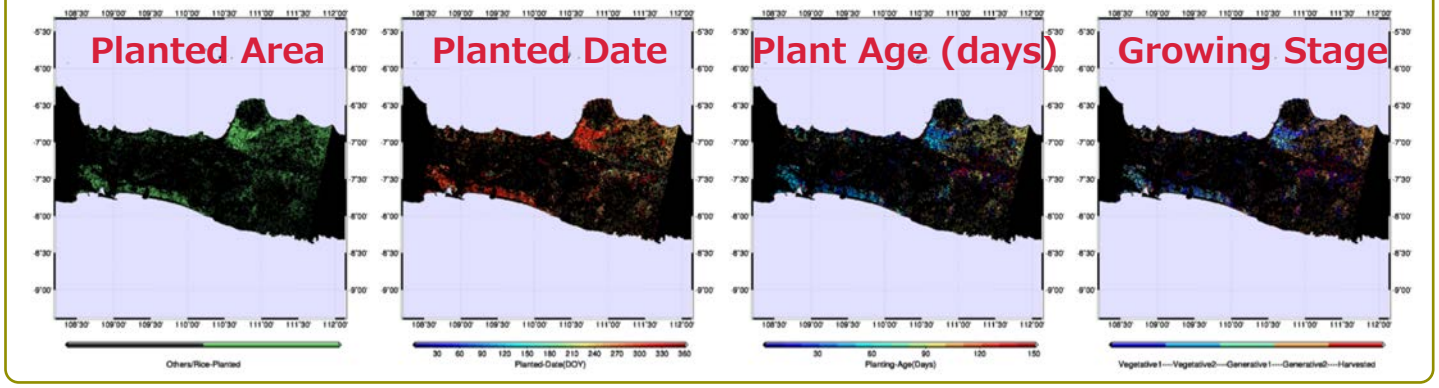
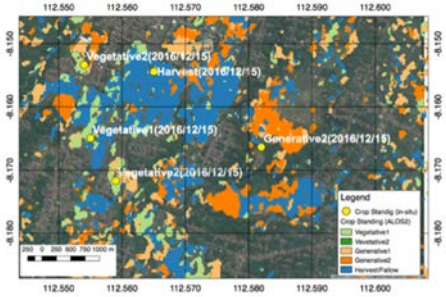
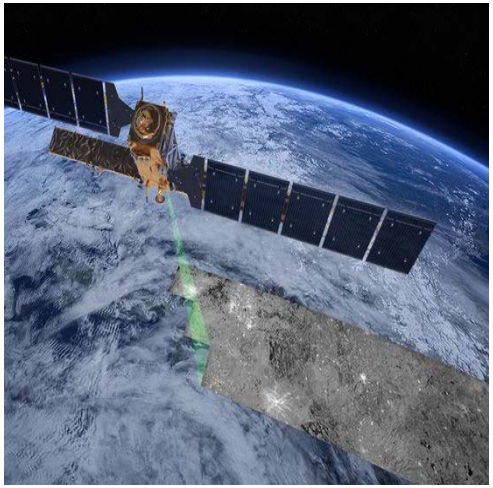
VNSC
Liftoff your Dream



Validation with in-situ data



Demonstrating scaling-up monitoring for rice by multi-temporal SAR data.



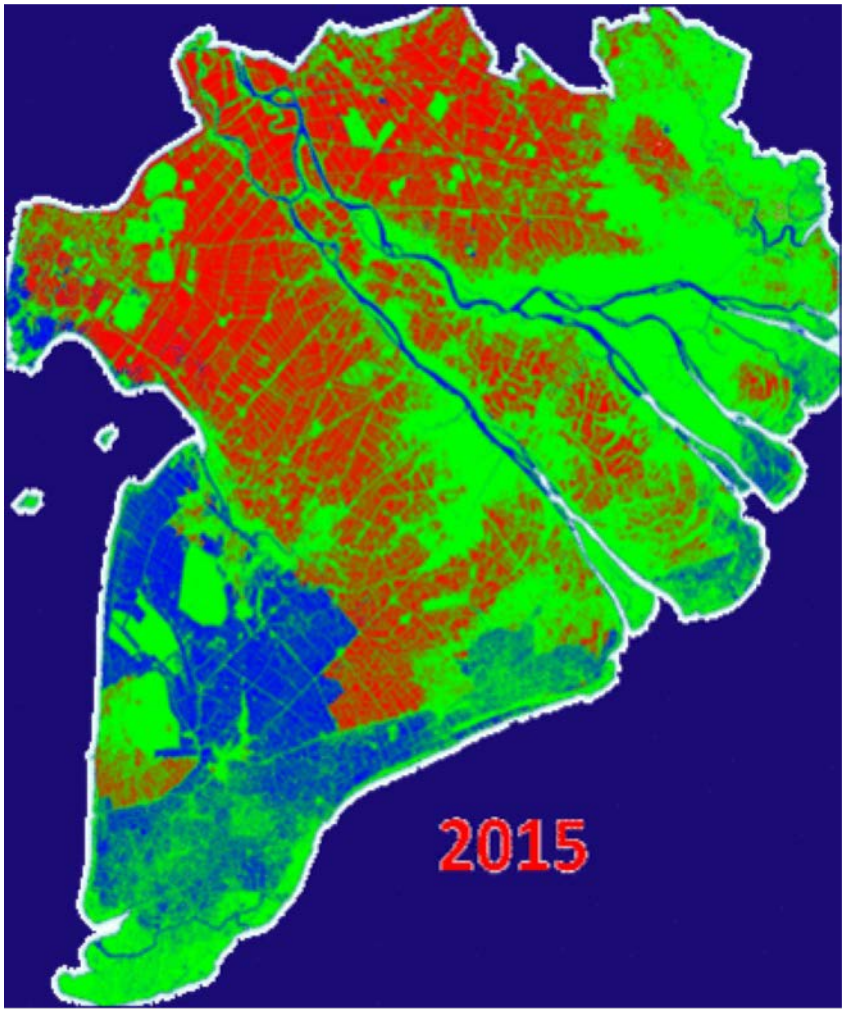
GEORICE
Sentinel-1 for Rice monitoring in Vietnam

CESBIO

esa

C-Band SAR data continuity

- Repeat Cycle: 12 days, 6 days with 1A & 1B
- Multimode, resolution 5-20m, swath width up to 250-400 km
- Open and Free access of data
- Preprocessing tools and Analysis Ready Data (ARD) available

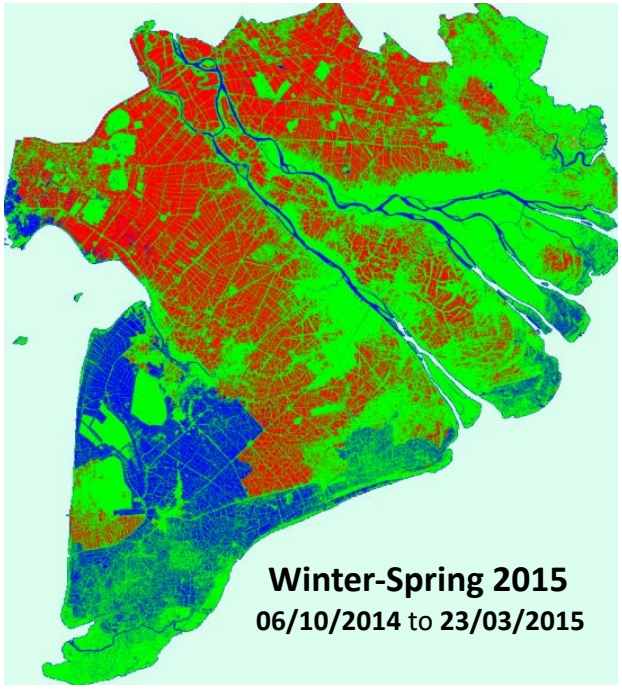


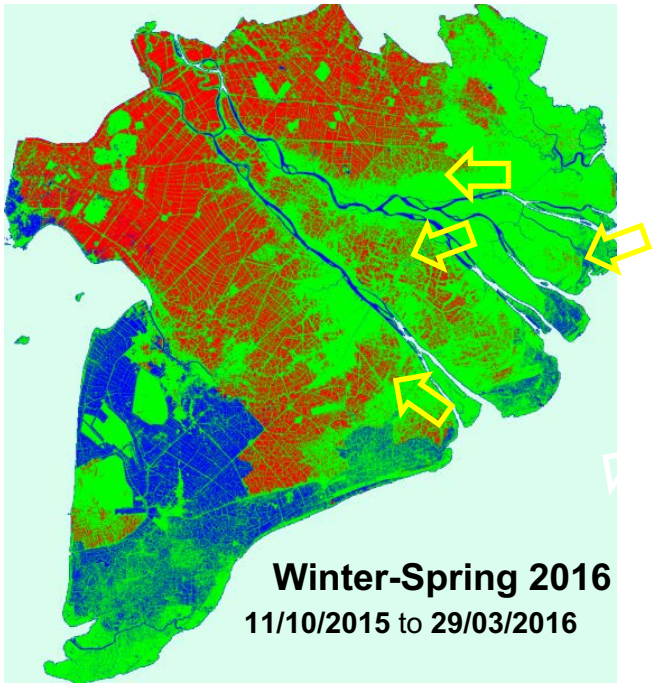
Effect of El Niño on rice crop cultivation, 2015-2016-2017 in the Mekong Delta

innovators georice

VNSC Lift off your Dream

Early estimate of variation in rice planted area



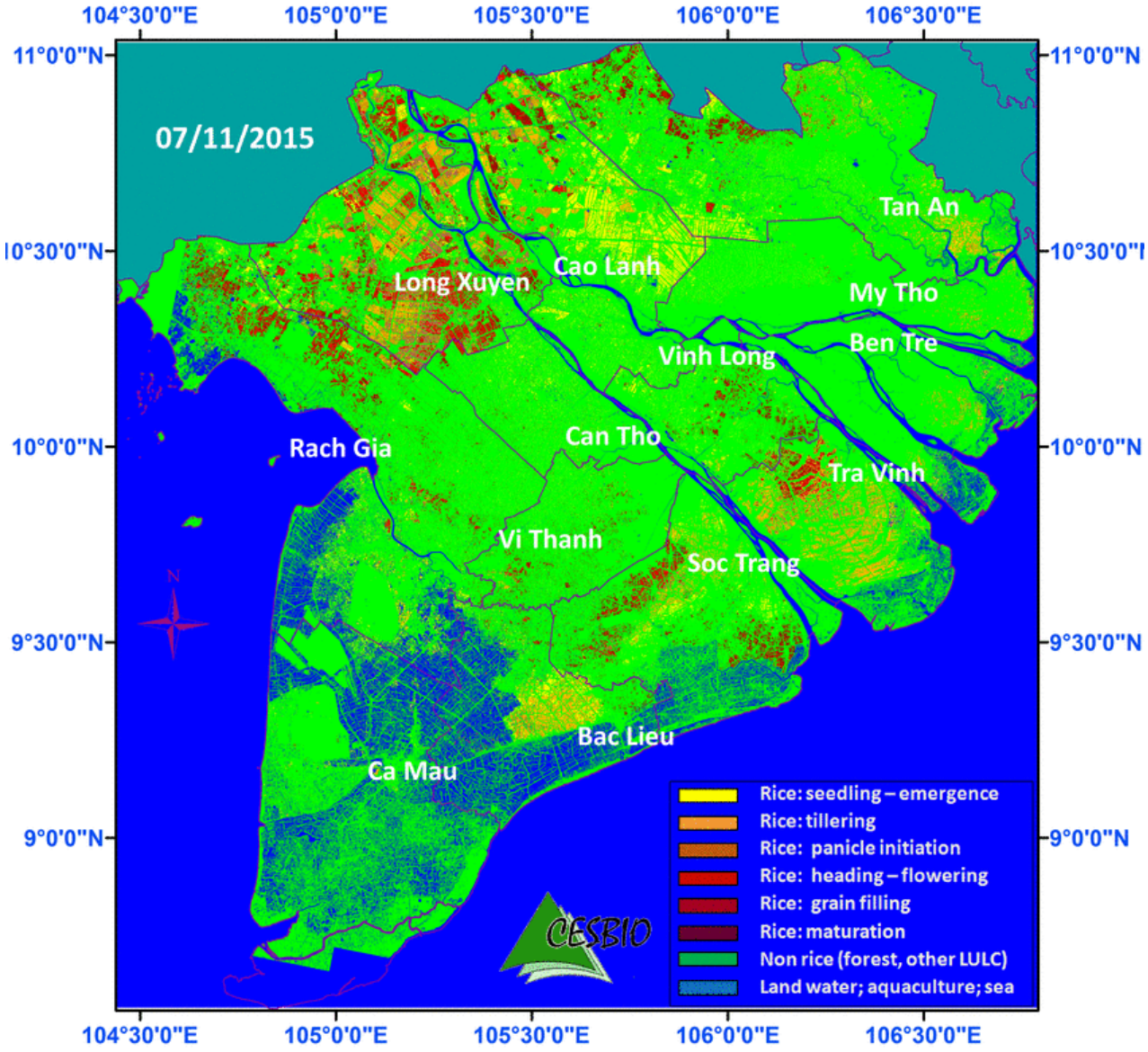


➡ **Decrease of 16.7%** of **Winter-Spring rice harvested area in Mekong River Delta 2016 compared to 2015 (**by March 2016**,** 1.39M ha estimated vs 1.67M ha in March 2015, or decrease of 276,000 ha) caused by **shortage of water** and **saline intrusion (El Niño effect)**

Other reportings:

- UNSCAP June 2016 : Damaged Winter-Spring paddy area in MRD of 234,260 ha
- VN Statistics Office 2017: **17,6%** of Winter 2016 rice planted area in MRD affected by drought and saline intrusion or 224, 552 ha

Rice growth stage monitored with Sentinel-1



GEORICE- Mekong River Delta

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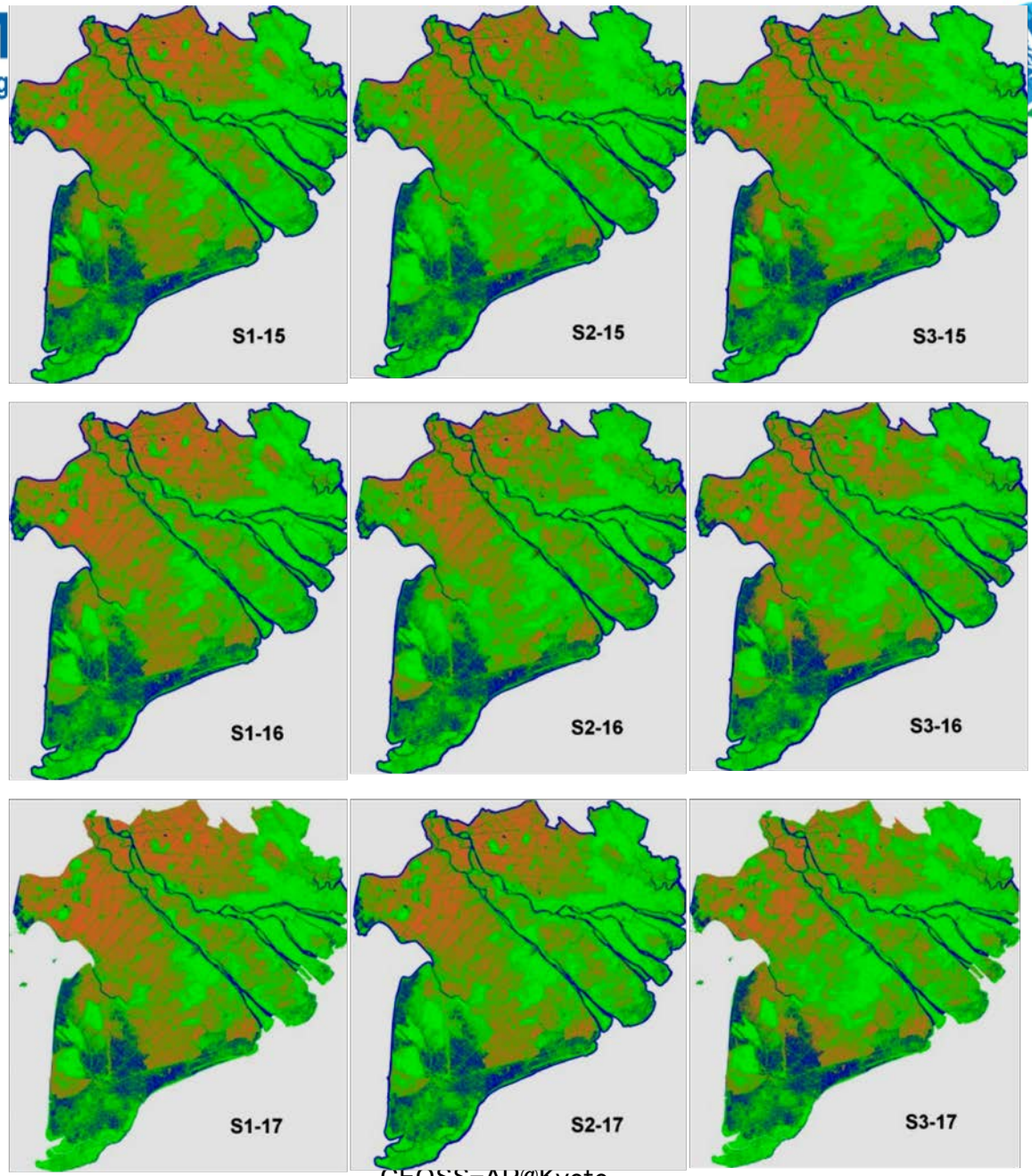

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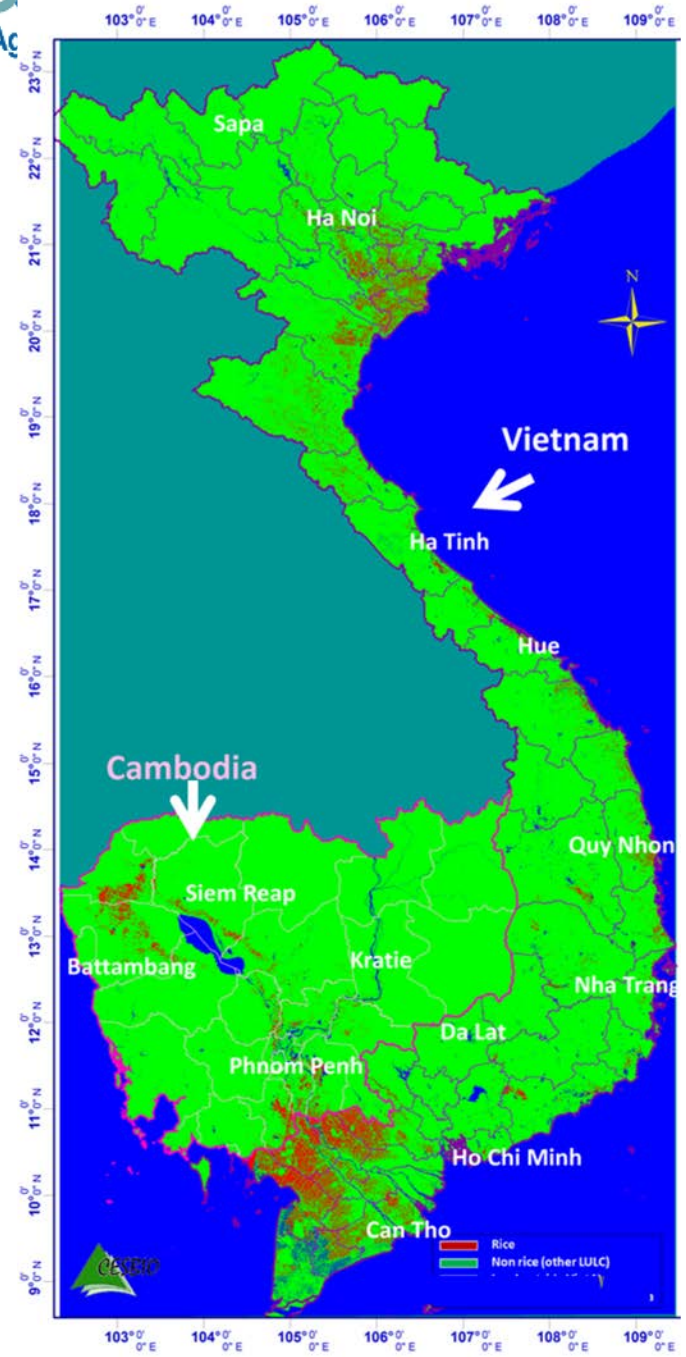
Rice | Non rice (Other LULC) | Land water; aquaculture

S1 : Winter-Spring || *S2 : Summer-Autumn* || *S3 : Autumn-Winter*

Test of wall-to-wall national mapping using Sentinel-1



Map of Winter-Spring 2016 rice in Vietnam and Cambodia

GEORICE phase 2
October 2018-March 2020

Vietnam Data Cube official release
6 March 2018, Hanoi

CEOS support over past 18 months

International partners

- CEOS SEO, CSIRO
- USGS
- JAXA, RESTEC
- CNES, CESBIO

ODC deployment and capacity

- Software and training (SEO, CSIRO)
- Hardware and maintenance (IMSG)
- Strategic support (Symbios)

ARD preparation and transfer to VN

- Landsat (USGS, SEO)
- ALOS, PALSAR (JAXA/ RESTEC)
- Sentinel-1 (SEO, CSIRO, CNES/CESBIO)
- ASTER DEM (SEO)

Application domains

- Forests (GFOI)
- **Rice (Asia-Rice, JAXA/RESTEC, CNES/CESBIO)**
- Water extent and quality and mangroves (Mekong, MRC)

Beyond food security, rice crop is closely linked to climate change, water and environment

Rice production is affected by climate change

- Drought, which damage the crop at reproductive phase
- Salinity intrusion, in particular in lowland South East Asia,
- Floods and cyclones, in increasing number

Increase rice production → increases use of water resources

- Irrigated rice receives an estimated 34–43% of the total world's irrigation water.
- increasing water scarcities in major river basins,
- retreating groundwater levels in areas where more water is being pumped for irrigation than can be replenished.

Beyond food security, rice crop is closely linked to climate change, water and environment

Rice fields are major generator of methane and nitrous oxide, responsible for 25% of the total budget of global methane emissions from agriculture.

Environmental issues increases with rice production :

Excessive use of fertilizers and pesticides that pollute waterways and kill beneficial wildlife,

As a task group, TG5 particularly addresses
SDG 2: *End hunger, achieve food security and improved nutrition and promote sustainable agriculture,* but also
SDG 6: *Clean and accessible water for all*
SDG 13 :*Take urgent action to combat climate change and its impacts*
SDG 15: *Protect, restore and promote sustainable use of terrestrial ecosystems*.

Questions to be addressed

How to increase rice production in conditions of climate change and reduced arable land, with reduced:

- water resources and chemical inputs

- methane and GHG and pollutant outputs

To address parts of these questions, one approach is to use models to simulate the effects of weather and cultural practices (inputs, water management..) on:

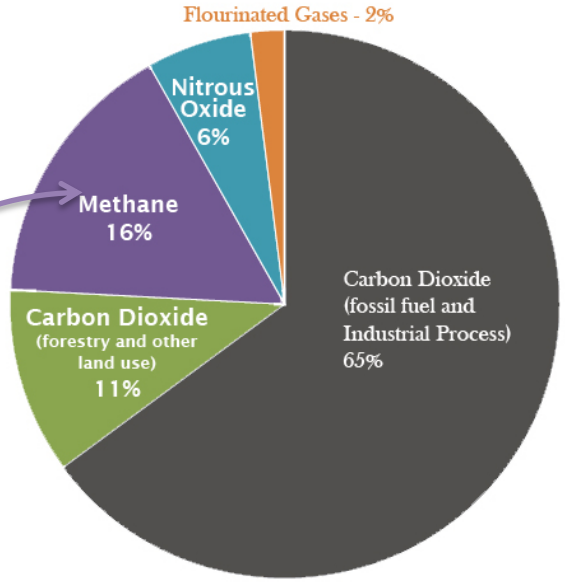
- rice yield (e.g. ORYZA2000)
- methane emissions and water used (e.g. DNDC)

The models used in situ data at experimental sites

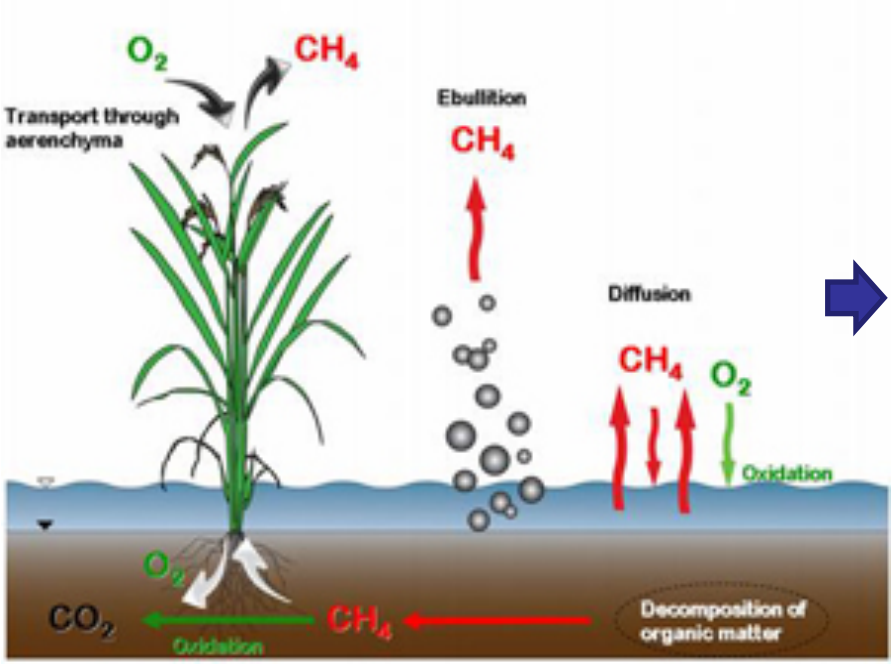
The use of EO to provide a number of model inputs is assessed

Rice fields source of atmospheric methane

This process contributes about 25% of the total budget of global methane emissions

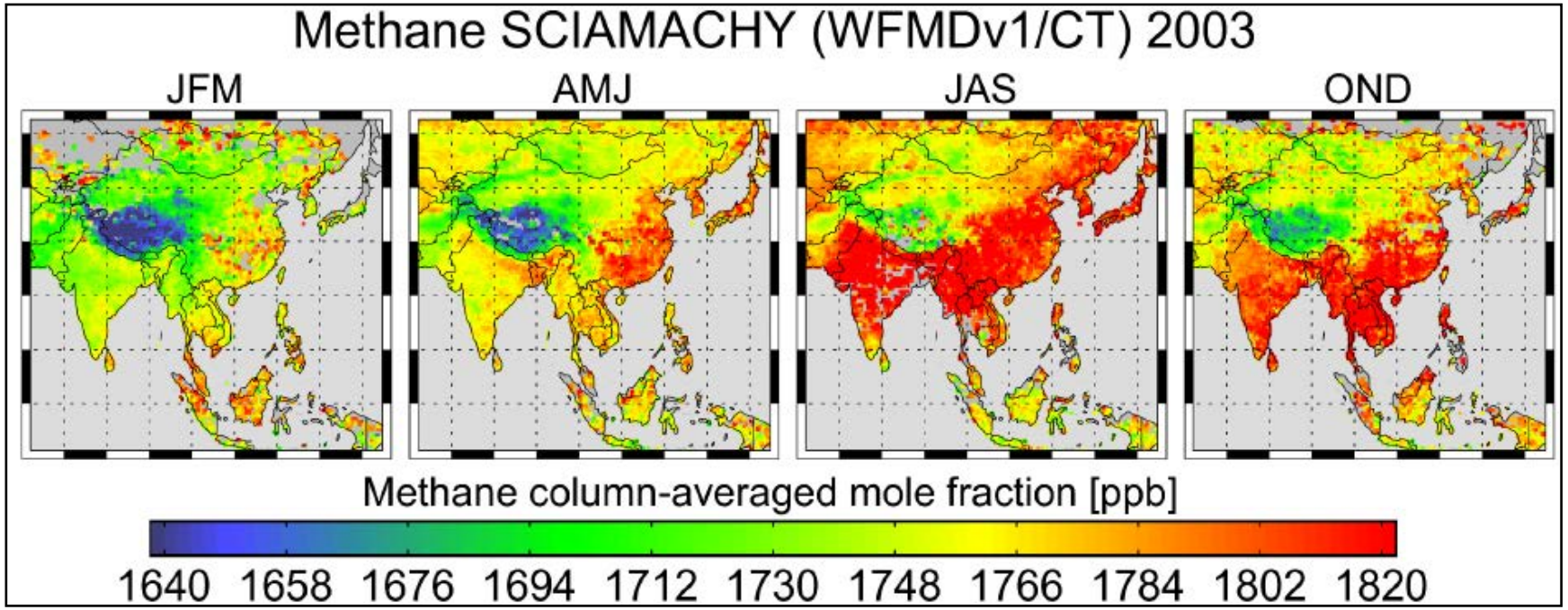


Greenhouse Gas Emission 2015



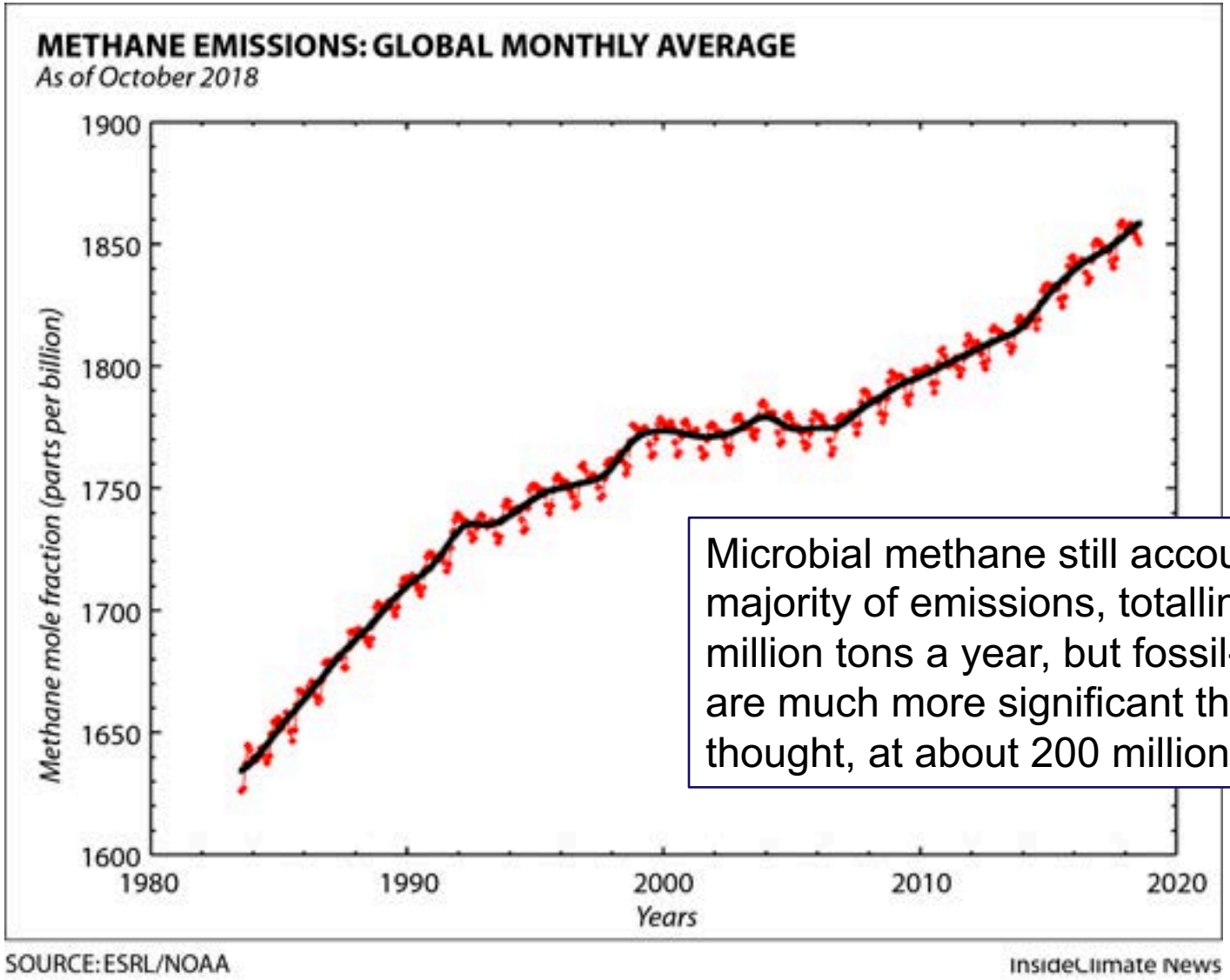
Feedback effect of rice production on climate change.

Rice grown countries and atmospheric methane

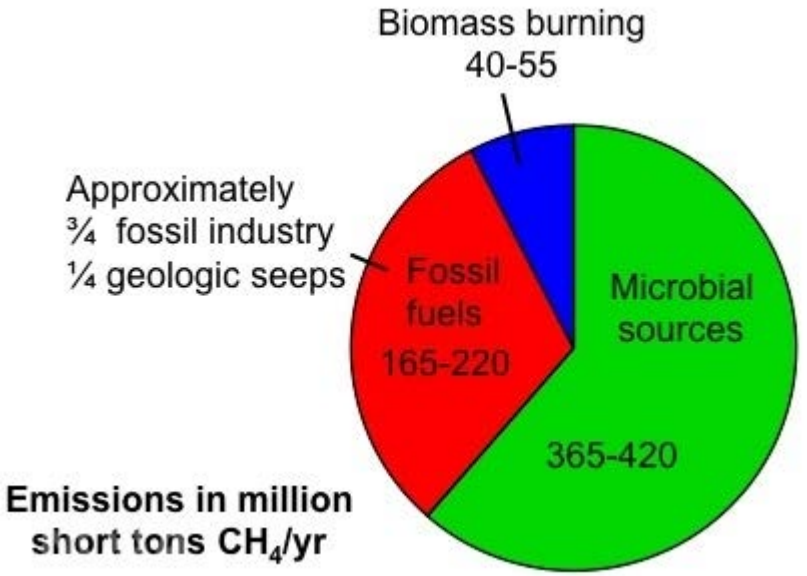


Schneising et al., ACP, 2009

Methane emissions increase again since 2008



Microbial methane still accounts for the majority of emissions, totalling almost 400 million tons a year, but fossil-fuel emissions are much more significant than previously thought, at about 200 million tons.



If microbial emissions are behind the recent rise, what can be done to reduce them?

A reduction in the amount of time that paddies are flooded can reduce methane emissions without sacrificing productivity ?

- Direct seeding versus transplantation
- Alternate Wetting Drying versus Continuous flooding

Rice , water consumption and GHG emissions

Water management scenarios:

1. **Continuous flooding** (CF): 5-12 cm from initial flooding to 5 days prior to harvest
2. **Alternate wetting and drying** (AWD): Water table fluctuates ±5 -10 cm from soil surface.

AWD

Biogeochemical Implications:

- Improve soil aeration;
- Stimulate root/shoot development;
- Increase soil mineralization.

Consequences:

- Increase crop yield;
- Decrease water consumption;
- Alter GHG emissions.

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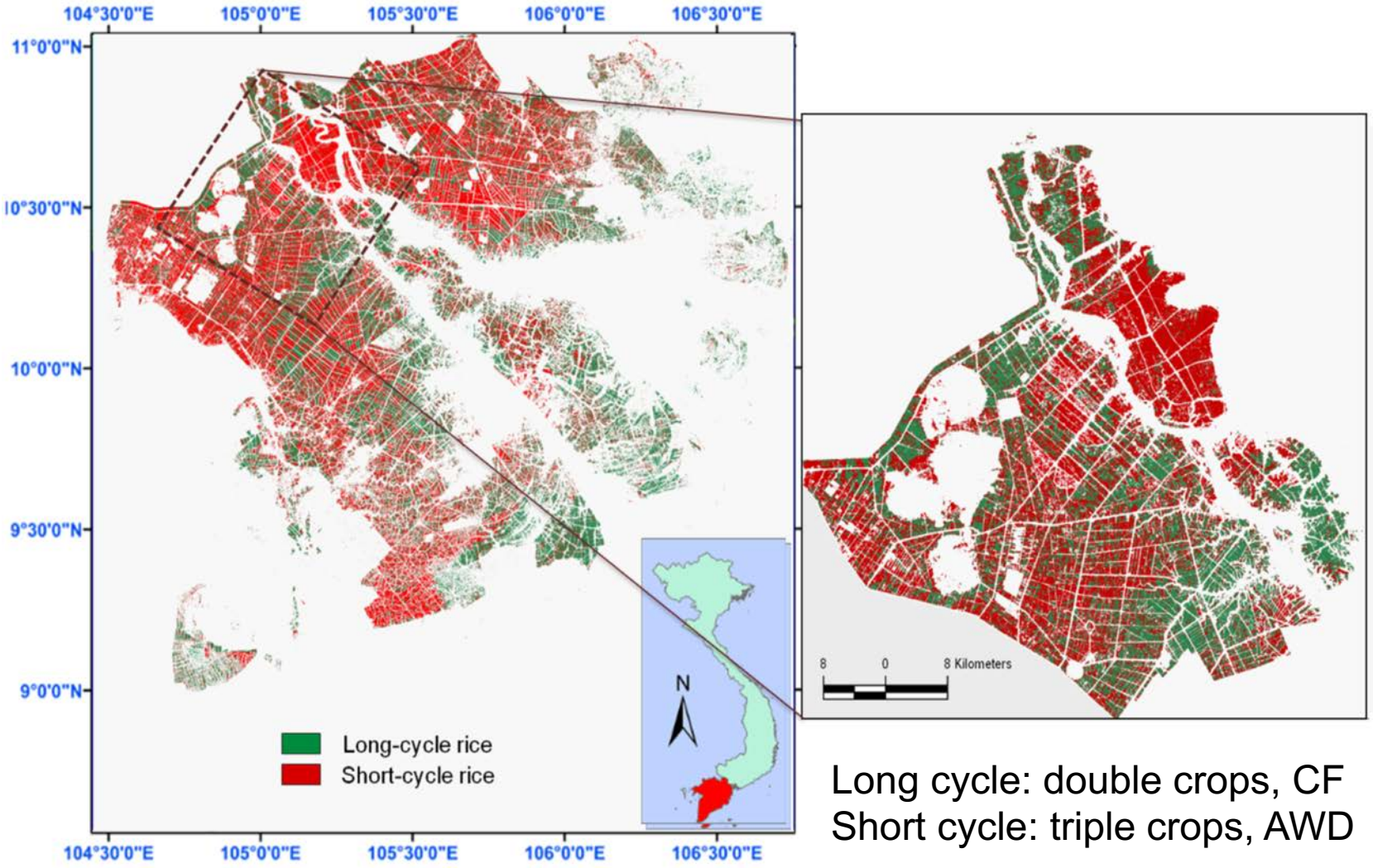
Rice planted with short cycle and long cycle varieties



Long cycle: double crops, CF
Short cycle: triple crops, AWD

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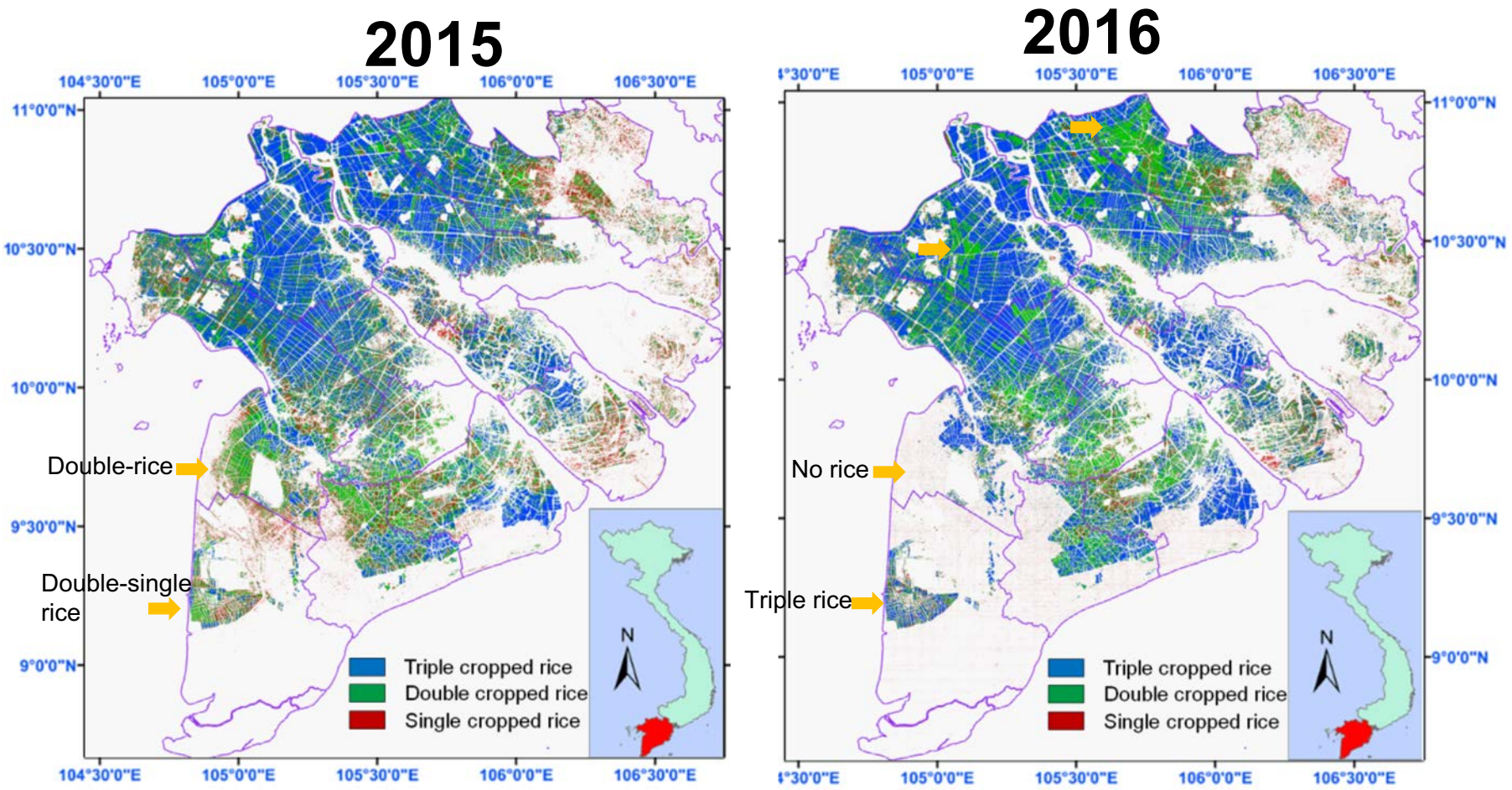
Year-to-year change in cropping density



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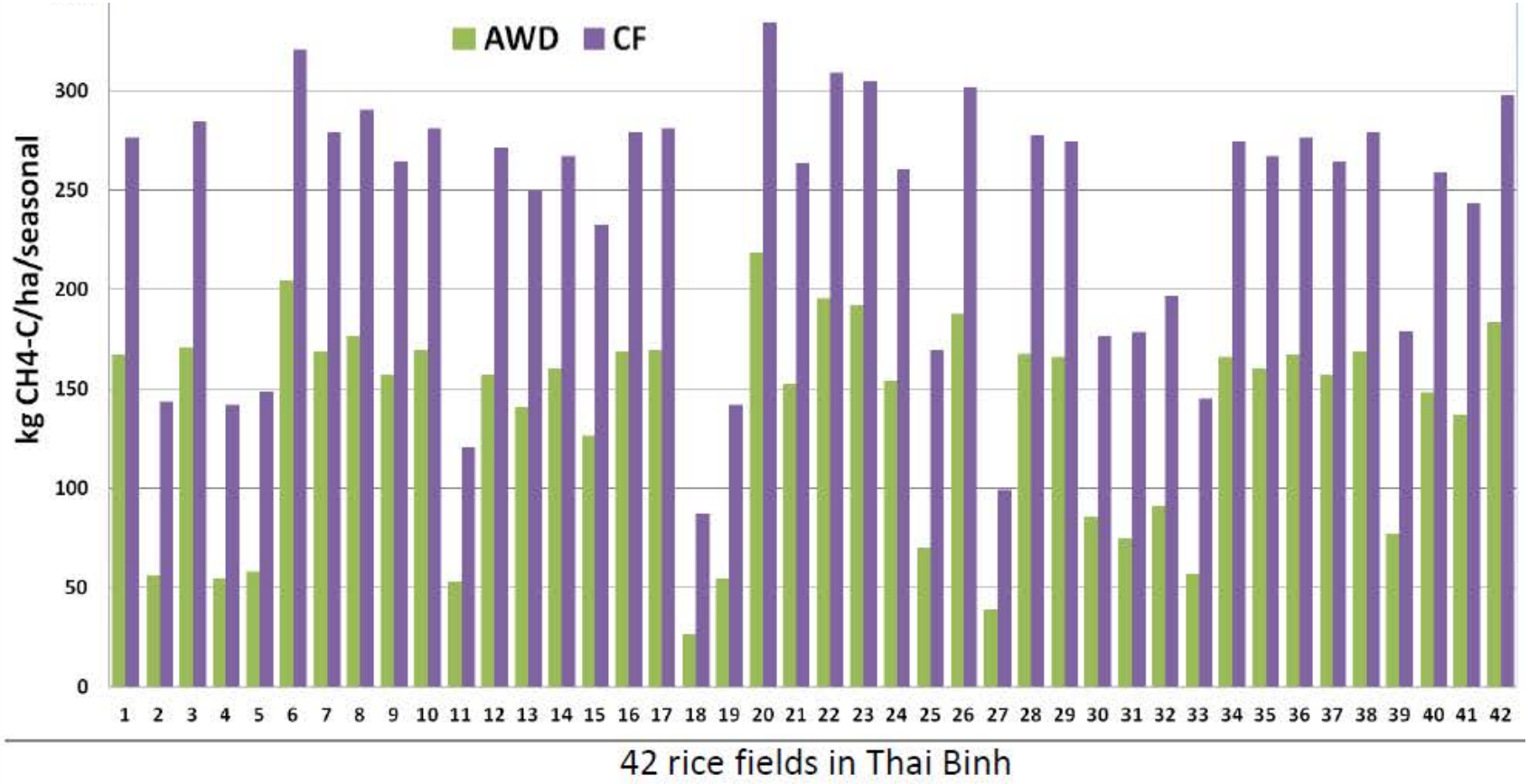
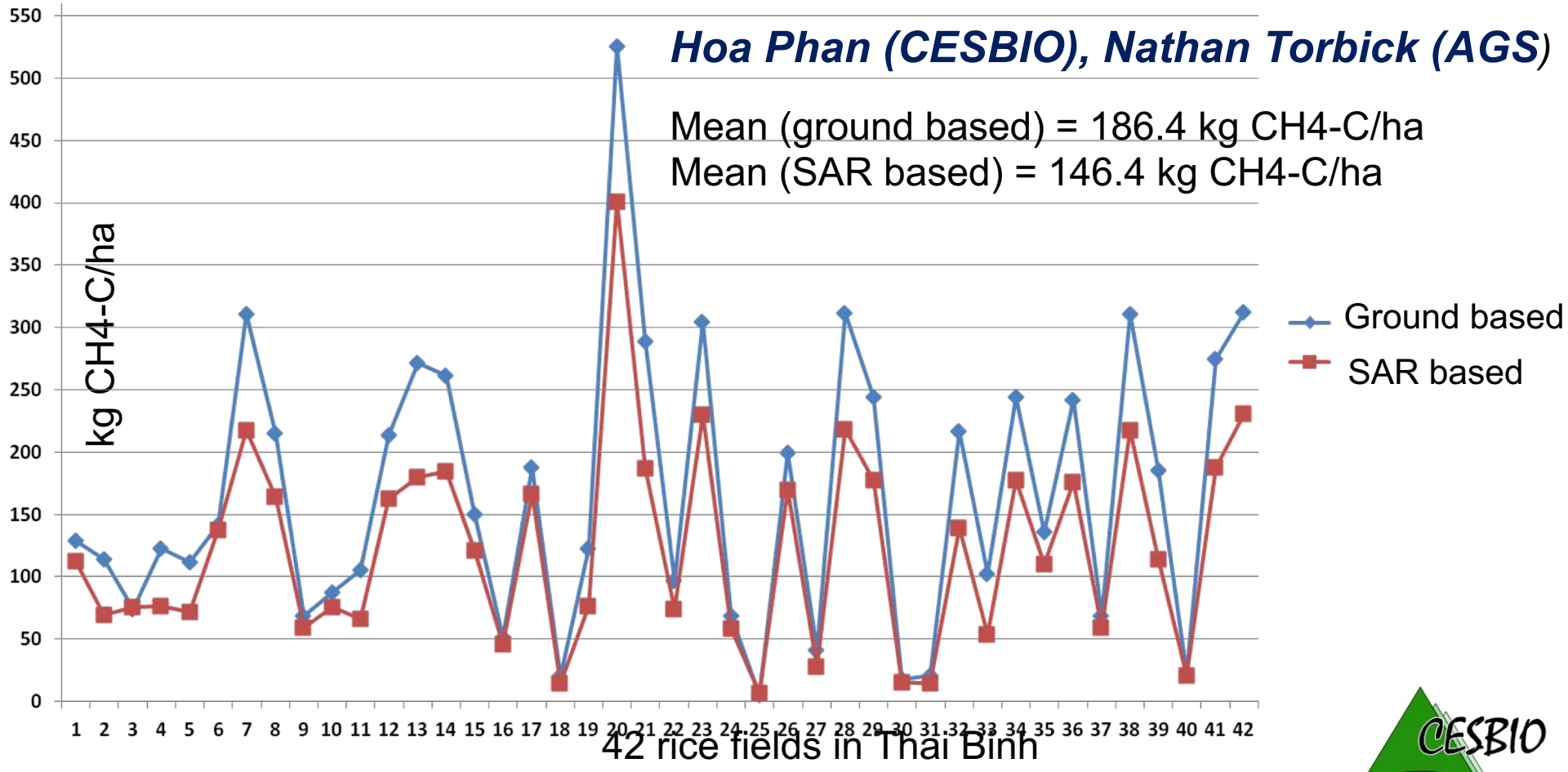
Experimental data in Red River Delta (W. Salass, N. Torbick, AGS)



- Continuous flooding produces the highest CH4 fluxes
- AWD management practices contribute to reduce CH4 emissions

Estimation of CH4 emissions for 42 fields in Thai Binh

Comparison of simulations based on parameters collected by ground survey and detected using Sentinel-1(**Season rice maps**, **cropping density** (SoS and harvest), **Growth stage**, **Inundation period**)



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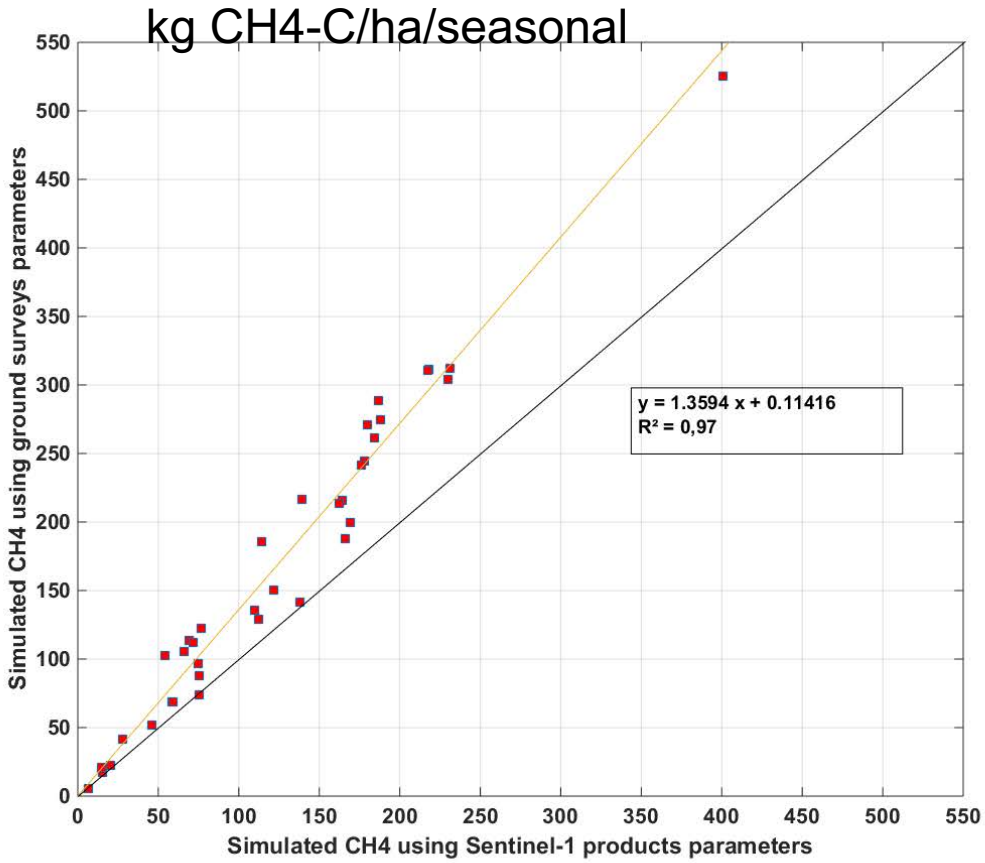
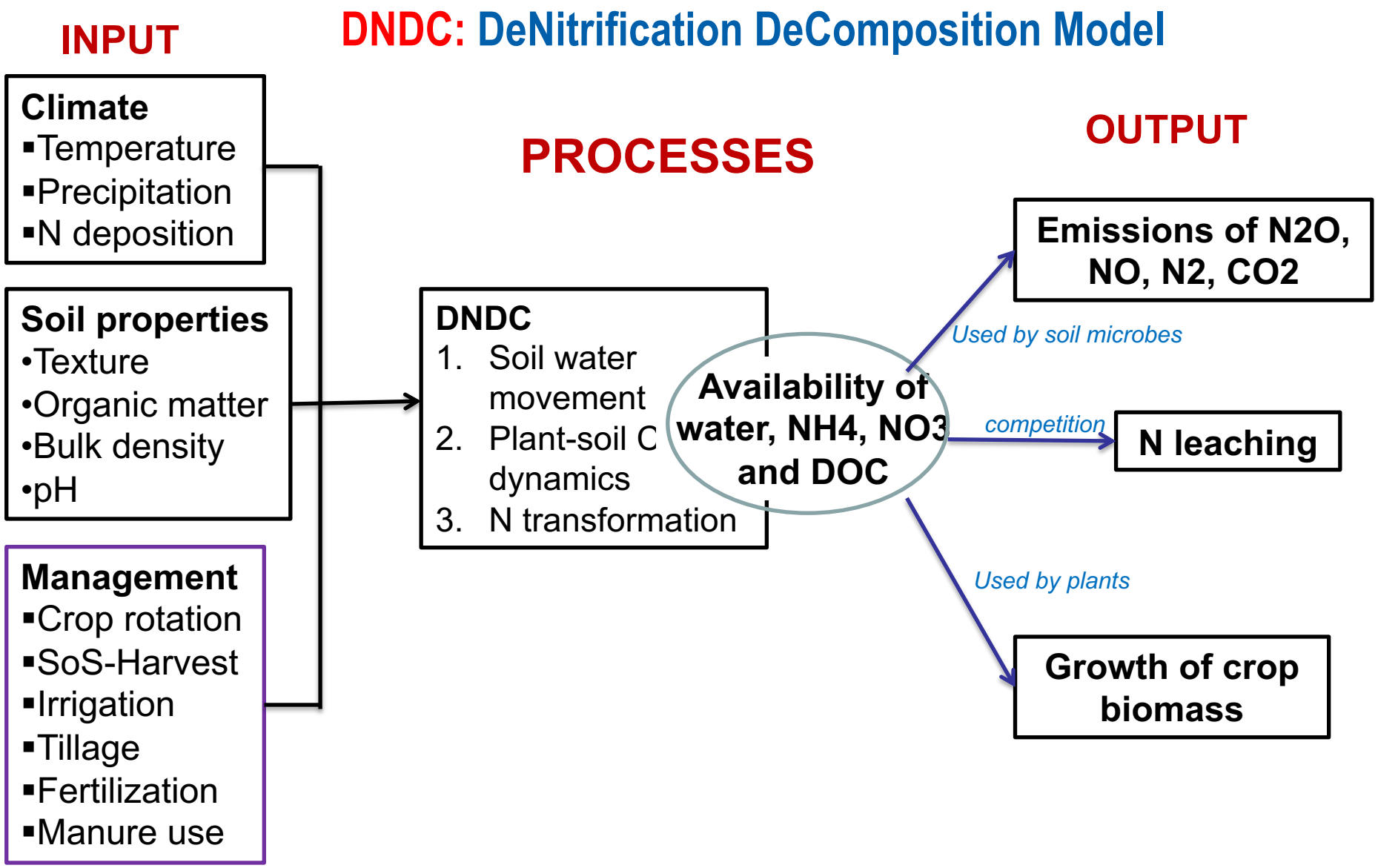


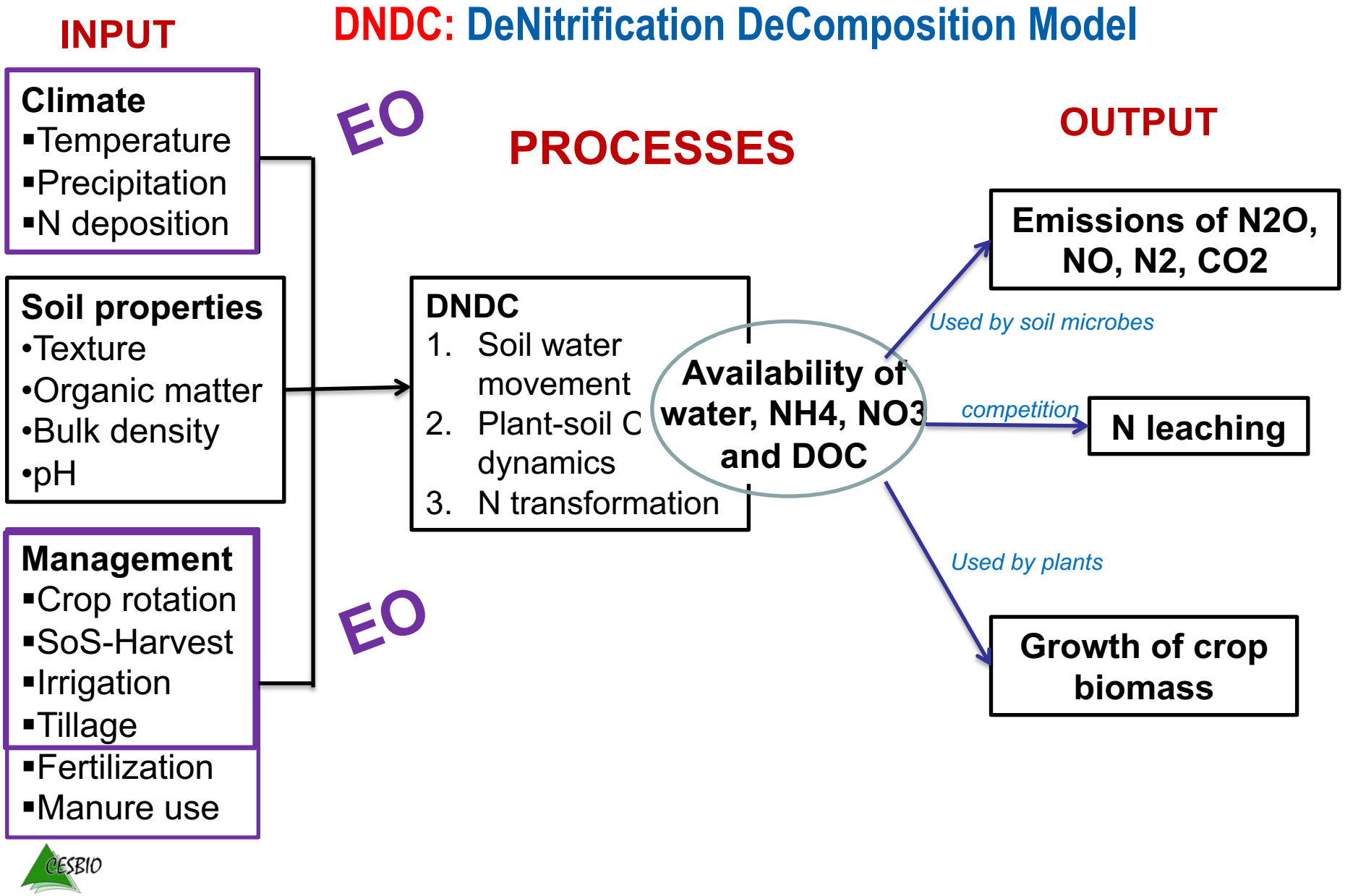
Sensitivity test of SoS and harvest, crop density and inundation period:

1. Inundation days is the most important factor
2. Cropping density
3. SoS and harvest

DNDC: DeNitrification DeComposition Model

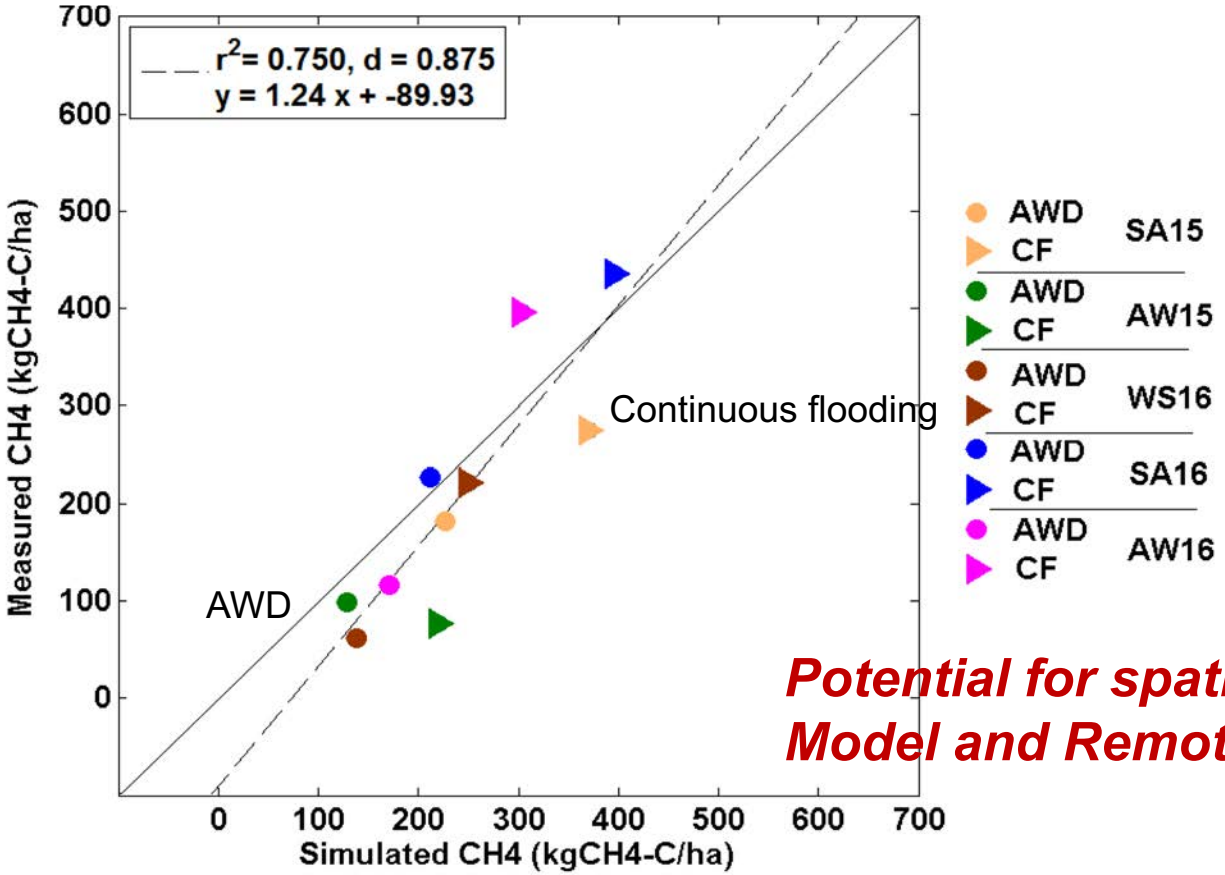


DNDC: DeNitrification DeComposition Model



Testing CH4 emissions with DNDC

Model input data over Mekong Delta sites
by the University of Tokyo (Hironori Arai)



Potential for spatialisation using Model and Remote Sensing

Way forward

1. To assess and harmonise remote sensing methods from Asia Rice partners ad to test the methods over rice ecosystems (rainfed, irrigated..)
2. To integrate satellite, ground-based data in multi-platform data base and models
3. To pursue integrated observations for food security, global change and environment

TG5 addresses the present status and perspectives of multi-platform observations for sustainable food security (SDG 2), and seek exchange with TG1 to address issued related to SDG13, climate change