Rice field survey
Lessons learned from GeoRice/Asia-Rice

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Earth Observation Technologies for Crop Monitoring: A GEOGLAM Workshop to Promote Collaborations among JECAM and Asia-RiCE 2018
17-20 September 2018 – Taichung City (Taiwan)
# Asia-Rice required Products

<table>
<thead>
<tr>
<th>General Description</th>
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<tbody>
<tr>
<td><strong>Service&amp;Product description</strong></td>
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<td><strong>Uses and benefits:</strong></td>
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## Product specifications

<table>
<thead>
<tr>
<th>Spatial scale:</th>
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<td>Country coverage (and larger)</td>
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<table>
<thead>
<tr>
<th>Minimum cell size (or mapping unit):</th>
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<td>20 m x 20 m</td>
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<table>
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<th>Required Information layers:</th>
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<tr>
<td>Rice-non Rice (water, urban, other crops)</td>
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<tr>
<td>Cropping intensity (one, 2 or three crops per year)</td>
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<tr>
<td>Phenology (Sowing date, End of vegetative phase, Harvest period)</td>
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<td>Rice parameters (biomass, LAI)</td>
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<td>Water management (irrigation scheme)</td>
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<tr>
<td>Indicators of crop production (growth anomaly, drought, insect..)</td>
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GEORICE: can we meet the requirements using Sentinel-1 data?

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

Automatically downloaded and preprocessed at CESBIO

Big Data challenge
Technical challenges in methodology development

S1 backscatter highly variable among rice fields

Due to diversity of rice crop calendar, varieties and cultural practices

Examples of RGB combinations of different dates of Sentinel-1 over rice fields in the An Giang province
Research needed for method development

To understand the S1 response of rice fields with a diversity of rice ecosystems over large areas (countries and beyond) and continuously changing conditions to adapt to industrialisation, labor shortage, climate change, production cost

- Rainfed, irrigated, upland rice, deep water rice, floating rice
- Single, double, triple rice crops, mixed rice & other crops or LU
- Rice varieties, short cycle, long cycle
- Cultural practices: transplanting, direct seeding,
- Water management in irrigated rice: continuous flooding or Alternative Wet Dry (AWD)
- Field size: small, large
- Diversity of inter-field and interannual rice crop calendar
- Mechanization: high, low
- Effect of climate change /disaster

Research needed for method development
Research needed for method development

Research topic: what governs the radar backscatter of rice fields, and the impacts of changing conditions?

Experiment: to study the temporal, polarization, and incidence angle behavior of the (S1) backscatter of rice fields from a set of sampled fields with a diversity of conditions

What field survey across the diversity of rice ecosystems and conditions?
Ground survey needed for:

1. Understanding of the information content of the SAR data wrt crop type and condition

2. Development of mapping and retrieval methods with error assessment

3. Validation of the results
Ground survey for backscatter understanding

- Survey across countries with a diversity of conditions
  - Need standardisation of survey/measurement method
    (e.g. within Asia-Rice )

- First phase: survey within a large region with sampled fields representing a diversity of conditions
  - Need a high number of samples
In situ data for understanding of the radar backscatter and algorithm development

60 sampling fields have been surveyed in An Giang at the same dates of S1.

Survey by the University of An Giang in collaboration with the VNSC /STAC and CESBIO

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

**Intensive information:**
- Phenological stage
- Height
- Biomass
- Soil condition
- Water management
- Uniformity of plant height
GUIDELINES FOR GROUND DATA COLLECTION

For
RICE MONITORING EXPERIMENTS USING SAR DATA

By
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Toulouse, France

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January 2015
Statistical assessment of ground data:
- the calendar can spread over 45 days and can have light shift (15 days) between years
Plant height as a function of plant age: effect of cycle duration

Long-cycle rice varieties
15 samples of Jasmine
\[ y = -0.006x^2 + 1.6x - 1.1 \]
\[ R^2 = 0.9345 \]
\[ \sigma_{rel} = 2.23\% \]
\[ RMSE = 6.72\text{ (cm)} \]

Short-cycle rice varieties
51 samples of IR50404, OM5451
\[ y = -0.0078x^2 + 1.7x - 4.2 \]
\[ R^2 = 0.9525 \]
\[ \sigma_{rel} = 1.16\% \]
\[ RMSE = 4.91\text{ (cm)} \]
Rice phenology for short/long cycle rice

12 stages

1. Seedling, emergence
2. 2/3 leaves
3. Tillering start
4. Tillering max
5. Stem elongation
6. Booting
7. Heading
8. Flowering
9. Milky stage
10. Milky hard stage
11. Maturation
12. Maturity -> harvest

TOTAL
90 to 140 days

Vegetative
25 to 75 days

Reproductive
35 days

Ripening
30 days

Germination
Panicle initiation
End of flowering
Mature grain

Erectophile structure
More random structure
# Rice phenology for short/long cycle rice

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<thead>
<tr>
<th></th>
<th>Vegetative</th>
<th>Reproductive</th>
<th>Ripening</th>
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<td>1</td>
<td>Seedling, emergence</td>
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<td>Booting</td>
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<td>12</td>
<td>Maturity -&gt; harvest</td>
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![Graph showing rice phenology stages](image_url)
### Rice phenology for short/long cycle rice

<table>
<thead>
<tr>
<th>Stage Type</th>
<th>Stage Details</th>
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<tbody>
<tr>
<td><strong>Vegetative</strong></td>
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<td>1</td>
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<td>Milky stage</td>
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<td>Maturation</td>
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<td>12</td>
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<td>Heading</td>
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<td><strong>Ripening</strong></td>
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<tr>
<td></td>
<td>Maturation -&gt; harvest</td>
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</tbody>
</table>

**Diagram:**
- **Short cycle rice**
- **Long cycle rice**

**Graph:**
- **X-axis:** Days after sowing
- **Y-axis:** Phenological stage

The graph illustrates the timeline of rice phenology stages, comparing short and long cycle rice varieties.
Understandig rice backscatter temporal evolution
Modelling work with RADARSAT-2
(data from Asia-Rice)
Understanding backactter evolution the rice cycle
Understanding backactter evolution the rice cycle
Understanding backacting evolution the rice cycle

*Interseason*
Multi-year analysis of rice backscatter
Sentinel-1 backscatter time series of rice fields

Example of time series of VH/VV and VV backscatter of 18 fields having same rice calendar
Deriving rice monitoring indicators

1. Rice/non rice indicators: specific temporal increase
2. Start of season from beginning of tillering (20 days)
3. Rice phenology: use of temporal trajectory of rice phenology, threshold depending on polarisation, incidence angle (and other LULC)
Effect of incidence angle and descending, ascending orbits
Effect of incidence angle
Deriving rice monitoring indicators

1. Rice/non rice indicators: specific temporal increase
2. Start of season from beginning of tillering (20 days)
3. Rice phenology: use of temporal trajectory of rice phenology, -threshold depending on polarisation, incidence angle (and other LULC)
   Also studied:
   - the effects of planting methods: transplanting, direct seeding
   - the effects of short/long cycle
   - the effect of small fields
Size and localisation of sampled fields
Wrt geometric accuracy of rice products

1. Rice map geometric accuracy of 1-2 pixels (mixed pixels at the border)
2. Small fields of few pixels mis-located (3 over 60)
Data for rice/non rice validation

In each of the 3 major rice regions in the Mekong delta

100 GPS samples of rice planting areas + 30 other LULC

In total, **413 data points x 5 seasons** at S1 dates
GPS Check points for assessment of Rice/non rice detection performance

The Mekong Delta: ~420X5 independent check points: 98%.

Error sources:
1. The precision of the GPS coordinates
2. The selected time interval for rice mapping method
Validation of phenological stage

An Giang

The Mekong River Delta, 30 January 2016

Kien Giang

Can Tho

Rice: seedling – emergence
Rice: tillering
Rice: panicle initiation
Rice: heading – flowering
Rice: grain filling
Rice: maturation
Non rice (forest, other LULC)
Land water; aquaculture; sea
Rice phenology detection

Map of the phenological stages at the date of 10/06/2016 in the region of An Giang

- Rice: seedling – emergence
- Rice: tillering
- Rice: panicle initiation
- Rice: heading – flowering
- Rice: grain filling
- Rice: maturation
In situ rice phenology verification

The % of good detection for 60 samples is **98.3%**.
Rice planted Area (in ha) for Summer-Autumn season 2016 provided by 13 provinces and estimated by GEORICE Agency statistics data for assessment of estimates of rice grown areas?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Estimated areas (ha)</th>
<th>Agency data (ha)</th>
<th>%</th>
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<td>219345</td>
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<td>2</td>
<td>Đồng Tháp</td>
<td>156310</td>
<td>193392</td>
<td>80,8</td>
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<td>3</td>
<td>An Giang</td>
<td>241450</td>
<td>239279</td>
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<td>4</td>
<td>Tiền Giang</td>
<td>98361</td>
<td>107513</td>
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<td>5</td>
<td>Vĩnh Long</td>
<td>51668</td>
<td>59339</td>
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<td>Bến Tre</td>
<td>11788</td>
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<td>7</td>
<td>Kiên Giang</td>
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<td>88968</td>
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<td>9</td>
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<td>Sóc Trăng</td>
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<td>Bạc Liêu</td>
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<td>1551362</td>
<td>1622297</td>
<td>95,6</td>
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Rice area statistics

Rice area extent for Summer-Autumn 2016 crop in the Mekong Delta
Comparison GEORICE estimates and Agency statistical data
### Rice area statistics

#### Calendar of the Summer-Autumn rice season in 2016 in the Mekong Delta

<table>
<thead>
<tr>
<th>Summer-Autumn</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<td>Vinh Long</td>
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<td>22/3</td>
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<td>Tien Giang</td>
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<td>Hau Giang</td>
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<td>Hau Giang 2016</td>
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**S1 data used for Summer-Autumn rice season**

- Change in start of season in 2016 to avoid drought/saline intrusion as observed in 2015

Over 11 other provinces: 98.3% agreement
Lessons learned

• Field survey needs to be designed to account for a diversity of rice conditions
• Ground data collection practices need to be updated
• Quantitative assessments are still needed to improve the sampling method
• Experiments/validation across a diversity of sites/countries are a necessity.