National and Regional Scale Rice Crop Monitoring in Asia with the RIICE and PRISM Projects: From Research to Operation

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OVERVIEW

Why rice?
Projects and partners
Crop monitoring approaches
Some example outputs
Observations on moving from research to operation
Rice growing areas of Asia. Green shows the most intensely cultivated rice areas.

Rice is grown on 160m ha, in diverse climates and environments. Around 90% is produced and consumed in Asia.

Rice is the most important crop in Asia for food security. It is consumed up to three times a day in several countries (over 100kg / capita / year compared to 5 or 6kg in US and Europe).

Rice is grown throughout the year across Asia, but concentrated in the monsoon season.
SAR BASED REMOTE SENSING FOR RICE MONITORING

Two simultaneous projects in Asia with the same technologies but slightly different goals related to food security

**RIICE**—to prove and develop business models at state or national scale for remote sensing based insurance for rice in India, Thailand, Vietnam, Cambodia, Indonesia and the Philippines. 2011-2014 (Phase 1), 2015-2018 (Phase 2)

**PRiSM**—to develop a nationwide rice crop information system for the Philippines. 2013-2017 (Phase 1), 2017- (Operational)

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**RIICE**
Remote sensing based Information and Insurance for Crops in Emerging economies.

Supported by SDC www.riice.org

**PRiSM**
Philippine Rice Information System

Supported by DA philippinericeinfo.ph
Remote sensing based Information and Insurance for Crops in Emerging economies.

Supported by SDC www.riice.org

Supported by DA philippinericeinfo.ph
Both projects aim to develop sustainable rice crop monitoring systems operated by national partners.

<table>
<thead>
<tr>
<th>Data</th>
<th>Technology</th>
<th>Information</th>
<th>Users</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote sensing</td>
<td>Remote sensing</td>
<td>Rice area</td>
<td>Ministries of agriculture</td>
</tr>
<tr>
<td>Weather, soil, etc.</td>
<td>Crop modeling</td>
<td>Planting dates</td>
<td>Statistical bureaus</td>
</tr>
<tr>
<td>Field measurements</td>
<td>Cloud computing</td>
<td>Yield &amp; production</td>
<td>Policy makers</td>
</tr>
<tr>
<td></td>
<td>Databases</td>
<td>Yield forecasts</td>
<td>Researchers</td>
</tr>
<tr>
<td></td>
<td>Expert knowledge</td>
<td>Flood damage</td>
<td>Disaster response</td>
</tr>
<tr>
<td></td>
<td>Smartphones</td>
<td>Drought damage</td>
<td>Finance/insurance</td>
</tr>
</tbody>
</table>

- Rice area
- Planting dates
- Yield & production
- Yield forecasts
- Flood damage
- Drought damage
- Ministries of agriculture
- Statistical bureaus
- Policy makers
- Researchers
- Disaster response
- Finance/insurance
Our first efforts focused on proof of concept in each country, training and working with partners on rice monitoring.

Methods for rice monitoring were developed and tested in 13 sites across South and South East Asia over a period of three years.

Rice area accurately mapped at sub hectare resolution in over 1.6m ha once per year for 3+ years across 13 sites in Thailand, India, Vietnam, Cambodia, Indonesia and the Philippines.

[tinyurl.com/rice-mapping]
The crop is monitored through the season, every season. Information provided as bulletins or via webGIS

RS processing chains are mostly automated and hosted on Amazon. Fieldwork data collected using geoODK and hosted on Amazon. Yield estimation soon to move to Amazon.
Multi-temporal SAR intensity to map rice area, start of season and LAI

$\sigma^0$ values from CosmoSkyMed X-band SAR, HH polarisation, 45°
Rice area estimates

Derived for the 2013 Spring/Summer seasons from 3m resolution CSK imagery, HH polarization, taken every 16 days through the season. Overall accuracy from 100+ field observations > 85%.
Crop establishment date

Nam Dinh in the Red River Delta

Soc Trang in the Mekong River Delta

Derived for the 2013 Spring/Summer seasons from 3m resolution CSK imagery, HH polarization, taken every 16 days through the season. Crop establishment date accurate to within 16 days.
<table>
<thead>
<tr>
<th>Site</th>
<th>Season</th>
<th>Period</th>
<th>Fields &amp; visits</th>
<th>Establishment</th>
<th>Maturity (days)</th>
<th>Water source</th>
<th>Validation points &amp; date(s)</th>
<th>Rice area (ha)</th>
<th>Accuracy and Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia, Takeo</td>
<td>Dry</td>
<td>Oct to Apr</td>
<td>4 fields, 20 visits</td>
<td>Direct seeding (DS)</td>
<td>95</td>
<td>Irrigated (IR)</td>
<td>100 08 &amp; 22-04,11-09-2013</td>
<td>150,026</td>
<td>85% 0.70</td>
</tr>
<tr>
<td>Philippines, Leyte East</td>
<td>Wet</td>
<td>May to Sep</td>
<td>20 fields 200 visits</td>
<td>Transplanting (TP)</td>
<td>114</td>
<td>IR</td>
<td>99 24 to 26-09-2013</td>
<td>17,817</td>
<td>87% 0.74</td>
</tr>
<tr>
<td>Philippines, Leyte West</td>
<td>Wet</td>
<td>May to Sep</td>
<td>20 fields 200 visits</td>
<td>TP</td>
<td>110-112</td>
<td>IR</td>
<td>85 27 to 28-09-2013</td>
<td>15,229</td>
<td>89% 0.79</td>
</tr>
<tr>
<td>Philippines, A. del Norte</td>
<td>Dry</td>
<td>May to Oct</td>
<td>18 fields 182 visits</td>
<td>TP &amp; DS</td>
<td>107-123</td>
<td>IR &amp; some rainfed (RF)</td>
<td>100 14 to 16-10-2013</td>
<td>13,163</td>
<td>89% 0.78</td>
</tr>
<tr>
<td>Vietnam, Soc Trang</td>
<td>Summer</td>
<td>Jun to Sep</td>
<td>12 fields 66 visits</td>
<td>TP &amp; DS</td>
<td>95-120</td>
<td>IR</td>
<td>108 25-09-2013</td>
<td>55,216</td>
<td>87% 0.74</td>
</tr>
<tr>
<td>Vietnam, Nam Dinh</td>
<td>Summer</td>
<td>Jul to Nov</td>
<td>20 fields 160 visits</td>
<td>TP</td>
<td>125-134</td>
<td>IR</td>
<td>100 30-08 and 05-09-2013</td>
<td>108,733</td>
<td>89% 0.78</td>
</tr>
<tr>
<td>Indonesia, Subang</td>
<td>Wet</td>
<td>Nov to Apr</td>
<td>20 fields 160 visits</td>
<td>TP</td>
<td>115-135</td>
<td>IR</td>
<td>115 10 to 13-02-2014</td>
<td>64,533</td>
<td>95% 0.90</td>
</tr>
<tr>
<td>India, Cuddalore</td>
<td>Samba</td>
<td>Jul to Jan</td>
<td>20 fields 160 visits</td>
<td>TP</td>
<td>130-160</td>
<td>IR</td>
<td>111 12-02 and 03-03-2014</td>
<td>26,015</td>
<td>92% 0.85</td>
</tr>
<tr>
<td>India, Thanjavur</td>
<td>Samba</td>
<td>Aug to Dec</td>
<td>20 fields 162 visits</td>
<td>TP &amp; DS</td>
<td>135-160</td>
<td>IR</td>
<td>102 31-01, 01-02 &amp; 07-03-2014</td>
<td>83,871</td>
<td>91% 0.82</td>
</tr>
<tr>
<td>India, Sivaganga</td>
<td>Samba</td>
<td>Sep to Jan</td>
<td>18 fields 110 visits</td>
<td>TP &amp; DS</td>
<td>100-110</td>
<td>Semi-dry rice</td>
<td>110 14 and 21-02-2014</td>
<td>41,825</td>
<td>87% 0.73</td>
</tr>
<tr>
<td>Thailand, Muang Yang</td>
<td>Wet</td>
<td>May to Nov</td>
<td>16 fields 130 visits</td>
<td>DS</td>
<td>150-178</td>
<td>RF</td>
<td>109, 17-10 and 12-12-2013; 12-02, 28-02-2014</td>
<td>91,908</td>
<td>86% 0.72</td>
</tr>
<tr>
<td>Thailand, Suphan Buri</td>
<td>Wet</td>
<td>Jun to Oct</td>
<td>20 fields 172 visits</td>
<td>DS</td>
<td>92-120</td>
<td>IR</td>
<td>100, 25-09, 25-10, 14-12-2013; 22-01-2014</td>
<td>555,317</td>
<td>87% 0.74</td>
</tr>
<tr>
<td>Philippines, Nueva Ecija</td>
<td>Wet</td>
<td>Jul to Nov</td>
<td>20 fields 200 visits</td>
<td>TP</td>
<td>114</td>
<td>IR</td>
<td>100,19-09, 03-10 and 04-10-2013</td>
<td>424,801</td>
<td>86% 0.72</td>
</tr>
</tbody>
</table>

All sites had at least 85% overall accuracy, suggesting that the classification method is **sufficiently accurate** across different managements, environments and varieties.
Leaf Area Index from SAR imagery used to calibrate a crop growth simulation model.
Yield forecast products uses weather forecast information in addition to real-time weather data. Two times of yield forecast is planned in RIICE, the first one in the middle of the season and the second about 2/3 toward the end of season. The second forecast and end of yield estimates are facilitated with more real-time weather data and additional SAR time series data as compared to the 1st forecast.
Yield estimates are provided as detailed maps and tabulated municipal averages at end of season. When compared against crop cuts, we obtain at least 85% accuracy at municipal level. Field level accuracy is much more variable - from 65%-95% agreement.
As well as crop cuts, we compare our estimates against published statistics. They are in general agreement. However we provide results more rapidly (in season and end of season) and at
Philippines - Flooded rice areas due to Typhoon Koppu (Oct 2015). An average of 20 tropical storms per year.
PROGRESS SO FAR

- Technological proof of concept (remote sensing + crop modeling + AWS + smartphone data collection) with promising results in all countries so far.
- Close to 10 million hectares monitored since 2011.
- Over 50 training courses across six countries.
- Political buy-in at national or state level in all countries except Indonesia (but the door is still open there).
- Highly visible outputs, especially related to yield forecasts, flood and drought damage assessments.
- Big investment from the Philippines government to move to a national scale operational system (10M USD for development), as well as in-kind investments from all other countries.
OUR TARGETS FOR PHASE II IN RIICE AND PRISM

- National partners, usually linked to government, adopt RS based crop monitoring into their operational activities at national scale or at least over the major rice producing areas.

- Use of the technology linked to at least one of the following:
  - Crop insurance applications (private or public)
  - Supporting/enhancing statistical information on crops
  - Enhanced damage assessment procedures
  - Land use planning and cadastral mapping

- Demonstrated impact for smallholders, either through RS based insurance or better targeted agricultural investments.
Scaling up with Sentinel-1A

By shifting the processing to a cloud computing platform, RIICE and PRISM partners have processed all available S1A data for 2015 for the Philippines, Thailand, Vietnam, Cambodia, Tamil Nadu and Odisha (India).

High impact outputs from 2015 include flood damage assessments in Tamil Nadu, drought assessments in Thailand and typhoon AND drought damage assessments in the Philippines as well as regular monitoring outputs on area, seasonality and yield.
1. Make sure you have begin users, not end users. Users must be there from the start in order to co-develop and co-own the technology, the application and the products. Each partner and each country has different views and requirements from the same technology. Working with each one to tailor the products to their most important criteria has worked well.

2. Pilots never fail, but pilots rarely scale. Solutions developed in the early stages of the project must be immediately scalable. We made several sub-optimal choices in Phase I, especially with field work, but rapidly moved to smartphone based data collection and AWS solutions (for example) to reduce costs and time for data collection and processing.
3. Top down high level political support can achieve faster results but slower, bottom up development is more robust and leads to more transparent and longer lasting collaborations. In almost every case we have secured support from national or state governments, but this has not always been there from the start. Rapid adoption is valued, but most success has been through slow, steady partnership development where we have jointly demonstrated proof of concept and then moved on to bigger joint initiatives.

4. Find your champion. Keeping them informed, engaged and in charge (steering committee) is essential. A supportive decision maker (minister or ministerial advisor level) has been essential in every successful implementation or example of buy-in so far.
5. **Constant contact, constant communication.** We’ve been successful in cultivating good relations with partners by **having our own local in-country managers work continuously with partners on all aspects of the projects, (capacity development, site selection, reporting, promoting)** but this is a big investment.

6. **Incentives and advancement.** Working with partners on publications, international training/workshops and spin-off ideas/projects is very important for sustaining relationships.

7. **Ownership and transparency.** Different institutes and different countries mean different policies and approaches. A very slow process to create ownership and promote (more) open access and wider use of the information being generated. GEOGLAM as a user/promotor/community.
THANK YOU

REMOTE SENSING BASED INFORMATION AND INSURANCE FOR CROPS IN EMERGING ECONOMIES.

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