MAPPING AND MONITORING RICE ECOSYSTEMS TO DRIVE DECISION SUPPORT TOOLS

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Background

Synergistic projects

1. NASA SBIR (NNX14CS01C): Rice Decision Support System (RiceDSS): Support global food security programs, disaster management, and commodity markets with fused rice info from EO, weather, and crop models

2. NASA LCLUC: Mapping LCLUC and sensor fusion in South Asia

3. USAID: Developing GHG Monitoring, Reporting, and Verification (MRV) and landscape accounting tools

Presentation Outline

A. Multiscale rice mapping with snapshot examples in S. Asia and USA

B. Modeling rice greenhouse gas (GHG) application in Red River Delta (RRD), Vietnam
Red River Delta Multiscale Imagery

HR / Google Earth

Sentinel-1 IW

Landsat 8 OLI

PALSAR-2 WB1
Multi-temporal remote sensing key for rice monitoring
Multi-scale Earth Observation integration workflow

Landsat 8 OLI → Ingestion, preprocess, projection, resampling: Uniform grid → Clouds (ACCA, FMASK, AutoCloud) → Weekly NDVI, LSWI, SATVI, MSAVI

MODIS → Coregistration

Sentinel-2 → Ingestion, preprocess, terrain geocoding, resampling: Uniform grid → Time series

Other optical → Time series

ALOS-2 → Ingestion, preprocess, terrain geocoding, resampling: Uniform grid → DEM, Layover, shadow, flags, quality masks

Sentinel-1 → Time series C & L backscatter dB

Other SAR →

Training Data:
- GeoField photos
- Field surveys
- Govt statistics
- HR images from NGA
- Google Earth

Construction of temporal vectors

Classification And Regression Tree Algorithms

Weekly Maps [extent, inundation, active v fallow, biomass metric]

Time Series Map [hydroperiod, growth stage, deviation from normal, risk, crop calendar, rotations]

Validation & Accuracy Statistics

Web-GIS

Applications: water management, yield modeling, scenarios
Collecting field training data for cal val, Ground Truth, surveys

http://www.eomf.ou.edu/photos/
Mobile Apps for Geofield photos; U. Oklahoma, Xiangming Xiao
Time series Landsat NDVI (greenness and biomass vigor)

DOY 107

DOY 113

DOY 139

DOY 155

DOY 209

DOY 225
DOY vs. NDVI for Corn, Cotton and Rice in Sacramento, 2009
DOY vs. SATVI for Corn, Cotton and Rice in Sacramento, 2009
Near real time comparisons against NASS

Annual Producer Accuracy (left) and User Accuracy / Reliability (right) of real-time rice extent mapping routine using Landsat imagery from 2007-2012 compared against NASS CDL for California.
The DNDC Model [gramp.org.uk]

Background

- **DNDC** stands for **DeNitrification-DeComposition**
  - DNDC is a soil biogeochemical model that has been used for quantifying GHG emissions from agricultural
  - DNDC is a process (as know as mechanistic) model that simulates the biogeochemical processes to drive C and N cycling in agricultural soils.
  - Long history of peer-reviewed publications (well over 200 publications).

Use for Rice Emissions Modeling

1. What is the rice GHG footprint in RRD?

2. How can multiscale RS improve parameterization and spatiotemporal drivers?

- DNDC can simultaneously simulate anaerobic (flooded) and aerobic (non-flooded) conditions in soils.
- DNDC can model both Methane and Nitrous Oxide emissions: critical for rice agro-ecosystems.
- DNDC has been extensively validated for rice globally.
Rice: CH₄ production and emission
(REDOX < -100 to -200 mv)

DNDC Models 3 Pathways
✓ Plant mediated transport
✓ Ebullition, diffusion
✓ Soil out gassing

Labile C → CO₂ + 4H₂ → CH₄ + 2H₂O
source

CH₃COOH + H₂ → CH₄ + CO₂

Methanogenesis

CH₄ + 2O₂ → CO₂ + 2H₂O
Methane oxidation

Ebullition

Slide from Will Horwath
Crops
Soils
Tillage
Irrigation
Fertilizer
Manure
Weather
DNDC
Driving DNDC with Earth Observations for GHG Assessment

Legend

1st crop planting DOY

- 0 - 26
- 27 - 42
- 43 - 46
- 47 - 54
- 55 - 57
- 58 - 61
- 62 - 65
- 66 - 73
**RRD 2015 Rice CH$_4$ Emissions**

<table>
<thead>
<tr>
<th>Method</th>
<th>CH$_4$ (GgCH$_4$-C/y)</th>
<th>CH$_4$ GWP (GgCO$_2$/y)</th>
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<tbody>
<tr>
<td>DNDC</td>
<td>345</td>
<td>11,515</td>
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<tr>
<td>IPCC Tier 1</td>
<td>mean 324</td>
<td>10,788</td>
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<tr>
<td></td>
<td>low 243</td>
<td>8,087</td>
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<tr>
<td></td>
<td>high 435</td>
<td>14,508</td>
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Summary
• PALSAR-2, Sentinel-1, Landsat 8 fusion high LULC accuracy
  • Multitemporal required for mapping rice attributes
  • Suite of parameters: extent, hydroperiod, intensity, calendar

• RRD GHG footprint characterized and uncertainty reduced with EO compared to IPCC Tier 1 approach

• Tuning & evaluating forecasts for select hot spots this upcoming year

• Open source tools, tech transfer, Decision Support Tools
  • Transition research to operational domain
  • github.com/Applied-GeoSolutions
  • Web-mapping, mobile, cloud,...
Please let me know if you are interested in applications & coordination
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Thanks to our hosts, NASA SBIR, NASA LCLUC program.

Questions?