JECAM Site-India/Vijayawada: Status

JECAM/GEOGLAM Science Meeting
Virtual Meeting
23 June 2020

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JECAM Site: Vijayawada, India

- Rice accounts > 40% of total grain production of India
- Cultivated and Consumed across the country

Why Andhra Pradesh state?
- Andhra Pradesh State: Rice bowl of India
- 11.6 million tonnes (2014-15): 11% of total India
- Yield: 3,036 kg/ha (2014-15)
- Cropping Area: 66% of total LULC
- Rice accounts: 28% of total cultivation area

Vijayawada, Andhra Pradesh site
- Covers Krishna and Guntur districts
- Availability of previous information
- Field campaigns - 2014 and 2015
- Rice dominated region

http://jecam.org/studysite/india-vijayawada/
Purpose of project: Crop characterization, mapping and Monitoring

Duration: 2017-2019

- **Location:** Southern State of India (16° 24' 6.23"N and 80° 41' 2.41"E)
  - Topography: Plain
  - Soils: Black cotton and Red Soils
  - Field size: 50 m X 50 m (approx.)
  - Irrigation dominated/Canal/Tanks

- **Crops:** Rice dominated
  - Others crops: Sugarcane, Corn, Turmeric
  - Crop calendar: Rice (July-November)

- **Climate and weather:** Tropical, 20°-35° C temp. range
- **Agricultural methods used:** Rice Transplanting as well harvesting by hand as well as by machines
Objectives

Research Topics:
- Crop identification and Crop Area Estimation
- Crop Cover Mapping
- Crop Growth Monitoring
- Biophysical parameter/Phenology Retrieval

JECAM India group is also engaged in development of:
- Novel Biophysical parameter retrieval techniques,
- SAR derived vegetation indices
- Processing Chain for Differentiating Early and Late Transplanted Rice in Google Earth Engine
- Compact/Hybrid Polarimetric data potential for crops
### Earth Observation (EO) Data Received/Used

<table>
<thead>
<tr>
<th>Data</th>
<th>Mission /Sensor</th>
<th>Space Agency /Supplier</th>
<th>Years of Acquisition</th>
<th>No. of Scenes</th>
<th>Polarization</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAR</td>
<td>Radarsat-2</td>
<td>MDA/(JECAM+SOAR) Canada</td>
<td>2014, 2018, 2019</td>
<td>20</td>
<td>Quad-Pol</td>
</tr>
<tr>
<td></td>
<td>RISAT-1</td>
<td>NRSC, ISRO, India</td>
<td>2013-2016</td>
<td>13</td>
<td>Compact-Pol</td>
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<tr>
<td></td>
<td>ALOS-2</td>
<td>JAXA, Japan</td>
<td>2019</td>
<td>25</td>
<td>Dual-pol</td>
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<tr>
<td></td>
<td>TerraSAR-X</td>
<td>DLR, Germany</td>
<td>2019</td>
<td>19</td>
<td>Dual-pol</td>
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<tr>
<td></td>
<td>Sentinel-1</td>
<td>ESA/ Openly available</td>
<td>2018, 2019</td>
<td>11</td>
<td>Dual-pol</td>
</tr>
<tr>
<td>Optical</td>
<td>Landsat-8</td>
<td>NASA/USGS, USA</td>
<td>2018-2019</td>
<td></td>
<td>Cloud free data</td>
</tr>
<tr>
<td></td>
<td>Sentinel-2</td>
<td>ESA, Europe</td>
<td>2018-2019</td>
<td></td>
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</tbody>
</table>

- As of now we did not face any major difficulty in data ordering and acquisition
In situ and Field survey Data

Parameters Collected: Plant Height, Soil Moisture, LAI (hemispherical photography), Phenology, management practices, water depth
In situ and Field survey Data

Field Photographs of JECAM, Vijayawada site: Current Status

05 July 2018

27 July 2018

22 Aug 2018

Challenges?

1. Crop cutting experiment: Biomass measurements
2. Inconsistent field shapes and sizes;
3. Difficult to design a common sampling strategy
Results: Highlights from work completed

- 2014 Kharif season field data and satellite data shared with JECAM|AAFC
- 2018 and 2019 In-situ measurements and shared with JECAM|AAFC
- Biophysical parameter estimation and classification
- JECAM India-Vijayawada webpage updated
Crop biophysical parameter retrieval

Rice - Plant Area Index (PAI)
Schematic workflow/ Rice PAI mapping

Water Cloud Model based inversion

2018 data

PAI Validation

- r = 0.84
- RMSE = 0.821
- MAE = 0.634

- Green: Tillering
- Blue: Stem elongation and booting
- Yellow: Heading and flowering
- Orange: Dough and maturity
PAI mapping

29-07-2018

22-08-2018

PAI, m² m²

7.0

0

15-09-2018

09-10-2018

2-11-2018
Vegetation growth condition monitoring

Generalized Radar Vegetation Index (GRVI) vs. Radar Vegetation Index (RVI)
GRVI based rice growth condition monitoring
GRVI based rice growth condition monitoring
Results: Correlation analysis

Direct Seeded Rice

Transplanted Rice

<table>
<thead>
<tr>
<th>Date</th>
<th>GRVI</th>
<th>RVI</th>
<th>Date</th>
<th>GRVI</th>
<th>RVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>05 Jul.</td>
<td></td>
<td></td>
<td>29 Jul.</td>
<td></td>
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</tr>
<tr>
<td>22 Aug.</td>
<td></td>
<td></td>
<td>15 Sep.</td>
<td></td>
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<tr>
<td>09 Oct.</td>
<td></td>
<td></td>
<td>02 Nov.</td>
<td></td>
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<tr>
<td>26 Nov.</td>
<td></td>
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</tr>
</tbody>
</table>

Leaf development | Tiller | Stem elongation and booting | Heading and flowering | Dough and maturity

\[ y = 0.0728x + 0.3128 \quad r = 0.84 \]
\[ y = 0.0367x + 0.2674 \quad r = 0.62 \]
\[ y = 0.0675x + 0.3811 \quad r = 0.83 \]
\[ y = 0.0463x + 0.2841 \quad r = 0.61 \]
PAI estimation from GRVI and RVI

(a) PAI estimates from GRVI

- **DSR**
  - $r = 0.82$
  - RMSE = 0.821
  - MAE = 0.787

- **TR**
  - $r = 0.80$
  - RMSE = 1.049
  - MAE = 0.834

(b) PAI estimates from RVI

- **DSR**
  - $r = 0.56$
  - RMSE = 1.182
  - MAE = 1.125

- **TR**
  - $r = 0.54$
  - RMSE = 1.304
  - MAE = 1.107

- **Legend**
  - Green: Tillering
  - Green: Stem elongation and booting
  - Yellow: Heading and flowering
  - Orange: Dough and maturity
Crop classification using RADARSAT-2 quad-pol SAR data

--from elements of Kennaugh matrix

--Classifier: XGB and RF
Cross-site validation – Canada (Carman) and India (Vijayawada)

Indian test site

Best user's (UA), producer's (PA) and overall (OA) accuracy for day-wise and time-series data for different crops for the Indian test site.

<table>
<thead>
<tr>
<th></th>
<th>XGB</th>
<th>RF</th>
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<tbody>
<tr>
<td></td>
<td>UA</td>
<td>PA</td>
</tr>
<tr>
<td>Day-wise</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banana</td>
<td>84.89</td>
<td>65.60</td>
</tr>
<tr>
<td>Cotton</td>
<td>70.73</td>
<td>70.73</td>
</tr>
<tr>
<td>Rice</td>
<td>80.10</td>
<td>66.60</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>84.92</td>
<td>89.65</td>
</tr>
<tr>
<td>Time-series</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banana</td>
<td>87.46</td>
<td>84.39</td>
</tr>
<tr>
<td>Cotton</td>
<td>82.31</td>
<td>88.31</td>
</tr>
<tr>
<td>Rice</td>
<td>84.18</td>
<td>66.28</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>90.29</td>
<td>91.85</td>
</tr>
</tbody>
</table>

Separability analysis
Time-series vs. day-wise data

Fig. 6. TSNE plots of the (a) day-wise and (b) time-series data stack over the Indian test site.
Cross-site validation—Canada (Carman) and India (Vijayawada)

Canadian test site

Best user's (UA), producer's (PA) and overall (OA) accuracy for day-wise and time-series data for different crops in Canadian test site.

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<tr>
<td></td>
<td>UA</td>
<td>PA</td>
<td>OA</td>
<td>k</td>
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<tr>
<td>Day-wise</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>86.59</td>
<td>79.34</td>
<td>74.97</td>
<td>0.66</td>
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<tr>
<td>Canola</td>
<td>82.95</td>
<td>77.68</td>
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<tr>
<td>Soybean</td>
<td>74.12</td>
<td>71.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>53.33</td>
<td>67.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time-series</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>70.97</td>
<td>96.85</td>
<td>80.41</td>
<td>0.73</td>
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<tr>
<td>Canola</td>
<td>85.34</td>
<td>91.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean</td>
<td>86.73</td>
<td>81.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>84.59</td>
<td>48.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Separability analysis
Time-series vs. day-wise data

(a) Day-wise
(b) Time-series

- Wheat
- Canola
- Soybean
- Corn
Crop characterization using iS-Ω decomposition for compact polarimetric SAR data

- iS-Ω
- S-Ω
- m-χ
Comparison of scattering powers
iS- $\Omega$ powers: Rice

Fig. 6. Scattering powers of iS – $\Omega$ decomposition at different growth stages of rice.
iS- $\Omega$ powers: Cotton

Fig. 7. Scattering powers of iS – $\Omega$ decomposition at different growth stages of cotton.
Fig. 8. Scattering powers of iS – Ω decomposition at different growth stages of sugarcane.
Publications:


Collaborations

• Describe the nature of any collaboration with other JECAM / Asia-RiCE sites or other relevant partners (i.e. who, objective, brief status).

Partners made:

• Andhra Pradesh State Remote Sensing Center (APSAC)
• Agri-Universities (Bidhan Chandra Krishi Vishwavidyalaya)

• Supports in field data collection, local knowledge, weather information
Plans for Next Growing Season

• Will you hold the course, or modify the approach?
  – Will follow the same course
  – JECAM India developed algorithms and methodology can be tested for other JECAM test sites also
  – A multi-year cross-validation framework is under process

• Do you anticipate using the same type/quantity of EO data next year?
  – Yes, we anticipate same type of EO data next year
Thank you for your attention!

Send your queries to:

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