JECAM
Joint Experiment for Crop Assessment and Monitoring

GROUP ON
EARTH OBSERVATIONS

GEO Joint Experiment for Crop Assessment and Monitoring (JECAM):

2013 Progress Report

March 2013

Executive Summary

This report shows the progress that GEO JECAM (Joint Experiment for Crop Assessment and Monitoring) test sites have made since JECAM started in 2011. The amount and types of Earth Observation (EO) data received are also reported, along with in situ data, analytical results, and future plans. JECAM is effectively the Research & Development (R&D) portion of the GEOGLAM (GEO Global Agricultural Monitoring) initiative, and so the R&D results are important for the development and sharing of 'best practices' in agricultural monitoring.

A historical background of JECAM is provided, showing how the concept evolved, and how the providers of Earth Observation (EO) data were engaged to support the initiative.

We have instituted an annual report process to obtain information on JECAM research progress, EO data usage and collaboration activities. **The progress of several JECAM sites to February 2013 is presented in this document.** There are currently sixteen JECAM test sites, of which three are dormant. Nine sites submitted progress reports. Others are in the process of applying to join.

A new website (www.jecam.org) was launched last year. Content from the annual reports will be used to keep the site 'fresh'.

The data acquisition planning with CEOS, Space Agencies and Commercial providers went fairly well and several JECAM sites are receiving data. The types of Earth Observation (EO) data used at each JECAM test site are shown in Table 1.

There have been 12 peer reviewed papers, 7 other publications and 10 presentations made by the 9 JECAM sites that reported.

The JECAM sites are looking at a common range of monitoring needs over a very diverse range of landscape conditions and cropping systems, including:

- Crop identification and acreage estimation
- Yield prediction
- Near Real Time Crop condition / Crop stress
- Land management
- Soil moisture.

All of the reporting sites included crop mapping as an objective. Seven of 9 include crop condition objectives. Seven of 9 also included crop yield forecasting research. Five of 9 included soil moisture monitoring research as an objective. Five of 9 reported residue and tillage monitoring research as an objective.

There is already significant bi-lateral collaboration between JECAM sites planned and underway. Use of the site network to support research external to JECAM is now taking place, including:

- ESA Sentinel 2 Simulation over JECAM sites
- IMAGINES project

- NASA-Canada SMAP Validation Experiment (SMAPVEX)
- UMD-Validation of LAI and FAPAR derived from coarse spatial resolution data.

Table 1: Types of EO Data Used at Each JECAM Test Site

JECAM Site	Cosmo Skymed	Palsar	RADARSAT-2	TerraSAR-X	AWIFS	DMCII	EO-1	HJ-1	Landsat	MODIS	Quickbird	Rapideye	SPOT-4/5
Argentina	x	x		x	x	x					x		
Belgium/France													
Canada/Red River			x	x	x							x	x
Canada/South Nation			x	x		x						x	
China/Anhui													
China/Guangdong													
China/Heilongjiang			x	x				x		x			
China/Jiangsu			x										
China/Shandong			x	x				x		x			
Italy Apulian Tavoliere													
Mexico													
Paraguay													
Russia													
South Africa									x				x
Ukraine			x				x						
U.S.A.													x

Experience with the use of the COVE tool for planning data acquisitions was mixed. Several sites expressed an interest in receiving training on the use of COVE.

The focus of JECAM has shifted to enhanced collaboration between sites. JECAM will continue to be responsive to GEOGLAM "R&D towards monitoring enhancements", and the GEOGLAM needs will define the JECAM community activities.

The JECAM network will be used to test/contrast/compare national monitoring approaches.

Regional studies will be developed to define best practices for harmonized national to regional monitoring. Comparative studies will develop standards and practices that inform the GEOGLAM "system of systems" for agricultural monitoring. JECAM sites will also participate in the validation of new sensors.

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1. Introduction

This report shows the progress that GEO (JECAM Joint Experiment for Crop Assessment and Monitoring) test sites have made since JECAM started in 2011. The amount and types of Earth Observation (EO) data received are also reported, along with in situ data, analytical results, and future plans. JECAM is effectively the Research & Development (R&D) portion of the GEOGLAM (GEO Global Agricultural Monitoring) initiative, and so the R&D results are important for the development and sharing of 'best practices' in agricultural monitoring.

2. Background

In November 2009, the first JECAM meeting was held at the SAR for agricultural monitoring workshop, in Kananaskis, Alberta, Canada. In December 2009, at the request of the GEO Agricultural Community of Practice, Canada took on JECAM coordination. In January 2010, a call was issued to the international community to provide standardized documentation of research sites.

In September 2010, a JECAM meeting was held in Hong Kong to focus on Asian sites and data sharing issues. In-situ data sharing protocols were developed. In October 2010, a meeting took place in Brussels, concentrating Europe and Africa. In May 2011, a meeting in Brazil focused on South America.

In order for JECAM to succeed, collaboration with CEOS (Committee on Earth Observation Satellites) is needed to ensure access to and sharing of Earth Observation (EO) data of the test sites around the world. Without coordinated acquisition of EO data of the test sites, JECAM will be unable to develop the agricultural monitoring system of systems. The world's space agencies have collaborated for the benefit of the international community before; examples of coordinated acquisition of data to support scientific efforts include (but are not limited to) the International Polar Year (2007 – 2009) and the GEO Forest Carbon Tracking task.

An international meeting of the JECAM secretariat was held with the space agencies and commercial data providers in Ottawa, Canada in June 2011 to discuss this question. Several data providers once again agreed to marshal their resources to provide coordinated EO data for this task which can be instrumental in addressing food security.

The benefits for CEOS and the space agencies are visible demonstrations of support to the international community on a matter of such high priority as food security. These demonstrations have the potential to translate into public support for CEOS programs. In the examples of the International Polar Year and the GEO Forest Carbon Tracking task, these benefits have been realized. Further benefits include validation of the usefulness of the data from each EO sensor for agricultural monitoring, and dissemination of the research results.

The overarching purpose of JECAM is to compare data and methods for crop area, condition monitoring and yield estimation, with the aim of establishing 'best practices' for different agricultural systems. The goal of the JECAM experiments is to facilitate the inter-comparison of monitoring and modelling methods, product accuracy assessments, data fusion, and product integration for agricultural monitoring. These international shared experiments are being undertaken at a series of sites which represent the world's main cropping systems and agricultural practices. The approach is to collect and share i) time-series datasets from a variety of Earth observing satellites useful for agricultural monitoring and ii) in-situ crop and meteorological measurements for each site.

Synthesis of the results from JECAM will enable the following outcomes:

(i) Development of international standards for agricultural monitoring and reporting protocols;
(ii) A convergence of the approaches to define best monitoring practices for different agricultural systems;
(iii) Identification of requirements for future EO systems for agricultural monitoring.

The JECAM sites are looking at a common range of monitoring needs over a very diverse range of landscape conditions and cropping systems, including:

- Crop identification and acreage estimation
- Yield prediction
- Near Real Time Crop condition / Crop stress
- Land management
- Soil moisture.

The Guide to Interacting with Space Agencies and Commercial Data Providers has been provided to each JECAM test site, so that they could access EO data by contacting the space agencies and commercial data providers directly, rather than via the JECAM Secretariat.

We have instituted an annual report process to obtain information on JECAM research progress, EO data usage and collaboration activities. The JECAM web site, www.jecam.org, was launched last year. Content from the annual reports will be used to keep the site 'fresh'.

There are currently sixteen JECAM sites in the following countries:

- Argentina
- Belgium/ France
- Canada (2)
- China (5)
- Italy Apulian Tavoliere
- Mexico
- Paraguay
- Russia
- South Africa
- Ukraine
- USA.

The following sections provide a progress report for the JECAM test sites up to February 2013. Section 14 describes JECAM support to important multilateral and bilateral work.

3. Argentina

Team Leader and Members: Carlos di Bella, Diego de Abelleyra, Santiago Verón

Project Objectives

The original objectives for the site have not changed.

- Yield Prediction and Forecasting. We are evaluating the correlation between several indexes and reflectance derived from satellite images (NDVI, SR, VWC, R and IR) and crop variables (fAPAR, biomass and yield).
- Crop identification and Crop Area Estimation. We are testing classification methods using optical and RADAR images and its combination. Among optical images, we are testing the effect of frequency of acquisitions and resolution and among RADAR the effect of band and polarization when available. Field observations of land use and crop type are carried out several times during a year to validate our classification results.
- Soil Moisture. During two field campaigns we measured gravimetrical superficial soil moisture several times during a year at crop and fallow fields with the aim to evaluate time windows of using different RADAR frequency images for soil moisture estimation.
- Crop Residue, Tillage and Crop Cover Mapping. We are registering fields of conventional and no tillage to test its identification using optical and RADAR images.

Site Description

- Location: San Antonio de Areco, Buenos Aires, Argentina

Location Area 1 – Crop Monitoring - High acquisition frequency:

Centroid	Latitude: 34.196300° S; Longitude: 59.576500° W
Top left	Latitude: 34.107537 S; Longitude: 59.684906 W
Bottom right	Latitude: 34.287877 S; Longitude: 59.465181 W

Location Area 2 – Crop mapping - Low acquisition frequency:

Centroid	Latitude: 34.1409° S; Longitude: 59.6867° W
Top left	Latitude: 33.8294S° S; Longitude: 60.0856° W

Bottom right	Latitude: 34.4579° S; Longitude: 59.3012° W

- Topography: Flat - slopes between 0 and 1 %
- Soils: Mostly Mollisols. Silt loam / Silty clay loam textured.
- Drainage class/irrigation: Well drained soils / Mostly rainfed fields
- Crop calendar

Main grain crops are soybean, maize and wheat. Early wheat is planted in June/July while late wheat is planted at the end of July and August. Wheat heading occurs in mid October and its harvest takes place at the beginning of December. After a wheat crop, a late soybean crop is commonly planted in December, and is harvested in April. Also, a late maize crop can be planted after a winter crop. Soybean and maize are mostly planted as one season crop. In these cases, soybean is planted in November and harvested in March/April and maize is planted in October and harvested in March.

- Field size: Typical field size is 20 ha but there is high variability in plot size.
- Agricultural methods used: Mostly no till agriculture. Main rotation (three years): Maize, Soybeans, Wheat/Soybeans.

<u>Earth Observation (EO) Data Received/Used</u>

TerraSAR-X:

- 24 scenes, between Dec 2011 – Jan 2013
- Beam modes/ incidence angles/ spatial resolutions:
    - StripMap Dual. Polarization: HH/VV. Incidence angle: 30.9/32.2º. Resolution 7 m.
    - ScanSAR. Polarization VV. Incidence angle: 27.3/36.5. Resolution 20 m.
- Processing level: Single Look Complex
- The acquisition planning tool for Terrasar-X (EOWEB next generation) is excellent. It is easy to know the area and the date of each future scene. All images requested were acquired with success.

ALOS PALSAR:

- Supplied by CONAE
- 9 scenes, between Aug 2010 – Mar-2011
- Beam modes/ incidence angles/ spatial resolutions:
    - FBD. Polarization: HH/HV. Off Nadir angle: 34.3°. Resolution: 20 m.
    - FBS. Polarization: HH. Off Nadir angle: 34.3°. Resolution: 10 m.
    - PLR. Quad Pol. Off Nadir angle: 21.5°. Resolution: 30 m.

- Processing level: 1.1 (Single Look Complex)

Cosmo-Skymed:

- Supplied by CONAE
- 18 scenes between Aug 2010 – Jan 2012
- Beam modes/ incidence angles/ spatial resolutions
  StripMap Ping Pong. Polarization: HH/HV and HH/VV. Incidence angle: from 27 to 52°. Resolution. 15 m.
- Processing level: Single Look Complex and Multilook

ResourceSAT/ AWIFS:

- 6 scenes between Nov 2011 – Nov 2012
- Beam modes/ incidence angles/ spatial resolutions. Resolution: 56 m.
- Processing level: Geocoded
- Although AWIS has a high potential acquisition frequency (near 5 days according to COVE output), images obtained at our study site were low for crop monitoring and the time of acquisition was not always optimal for crop classification. Previous knowledge of possible acquisitions is useful for planning field campaigns.

Quickbird:

- 4 scenes between Dec 2010 – Jan 2011

DMCii:

- 7 scenes between May 2012 – Dec 2012

RADARSAT-2:

Several RADARSAT-2 images were acquired from October 2010 to April 2012 but we didn't receive the images yet. During February, we expect to receive the first RADARSAT-2 images. Such a delay between acquisition and delivery times, in addition to delay in the generation of results, makes it difficult to redefine acquisition strategies and identify current aspects of crops being monitoring.

<u>In situ Data</u>

Intensive field measurements of crop and environmental variables were performed during the first three years of the project (2010-2013) to develop and calibrate methodologies for biomass and yield estimations and crop mapping.

Figure 1: In situ Measurements, Argentina

Measurements were performed at several times during wheat (August to December) and soybean (November to April) crop growing periods:

- Fraction of Absorbed Photosynthetic Active Radiation (fAPAR)
- Green Cover / LAI. Digital images were taken using a Digital Camera with wide angle Lens.
- Crop wet and dry biomass. Periodical harvests were performed. Plants were weighted wet and after oven drying.
- Soil moisture measurements (0-5 cm). Gravimetric method.

Additional measurements:

- Crop Yield
- Plant density
- Row direction.

Regional surveys during key crop developing stages with visual identification:

- Land use: Agriculture / Livestock
- Crop type: Wheat, Barley, early and late soybean, early and late maize.
- Crop Phenological stages (wheat heading, maize antesis)
- Tillage system.

Collaboration

We started joint collaborations with the China JECAM site leaded by Prof. Bingfang Wu. We defined a common agenda on comparison of crop monitoring methods, and a participant from China came to Argentina last year. We expect to travel to China this year to continue with this collaboration, but we are having difficulties getting funds to support these activities. We suggest that specific funds should be assigned from the GEO-JECAM budget for such activities, since collaboration among participants is one of the main objectives of this initiative.

Results

Crop monitoring:

Several of the field measurements campaigns were carried out on dates of satellite image acquisitions (including ALOS PALSAR, TERRASAR, Cosmo Skymed, RADARSAT-2, MODIS daily reflectance). Consequently, the team collected a high quality dataset of field measurement variables (fAPAR, LAI/green cover, crop wet and dry biomass, soil moisture) and simultaneous acquisitions of a wide range of satellite images of different wavelength (optical, SAR), temporal and spatial resolution (Figure 2, Figure 3 and Figure 4).

Different satellite data derived information (e.g. Infrared reflectance, NDVI, Simple ratio - SR, backscatter at different bands and polarizations) are being correlated with field measurement variables. Field measured fAPAR was strongly correlated to daily MODIS reflectance data corrected by directional effects. Soybean biomass was derived from a Montieth approach based on NDVI data as well as using RADAR backscatter in X band. Full analysis requires the delivery of all the data acquired over our study site (e. g. several RADAR bands), some of which had a considerable delay between acquisition and delivery. (RADARSAT-2 acquired during 2010-2012 are expected to be delivered during this year). Another difficulty is the lack of overlapping periods of availability of different satellite systems as follows:

ALOS PALSAR (L band): from August 2010 to April 2011

RADARSAT-2 (C band): From December 2010 to April 2012

TerraSAR-X: Since December 2011.

Figure 2: Dates of Intensive field measurements and Satellite RADAR data acquisitions during 2010/2011 agricultural field campaign for wheat (A) and soybean (B)

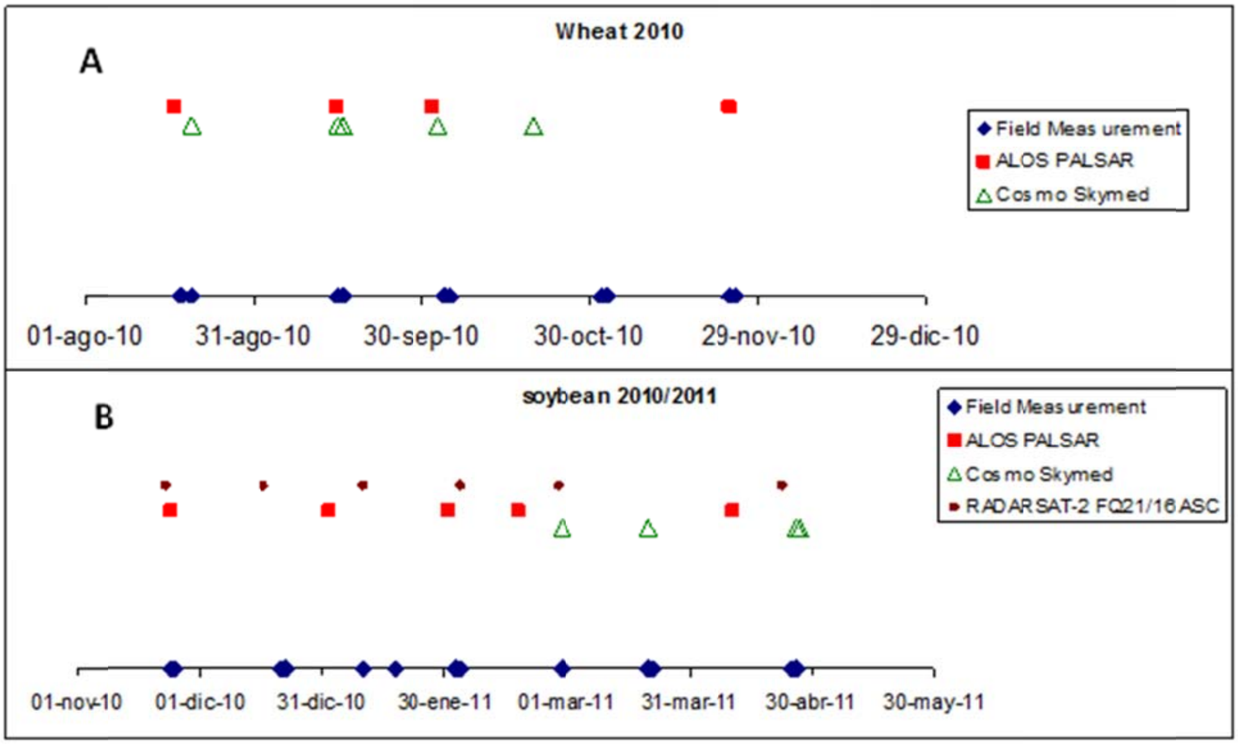


Figure 3: Dates of Intensive field measurements and Satellite RADAR data acquisitions during 2011/2012 agricultural field campaign for wheat (A) and soybean (B)

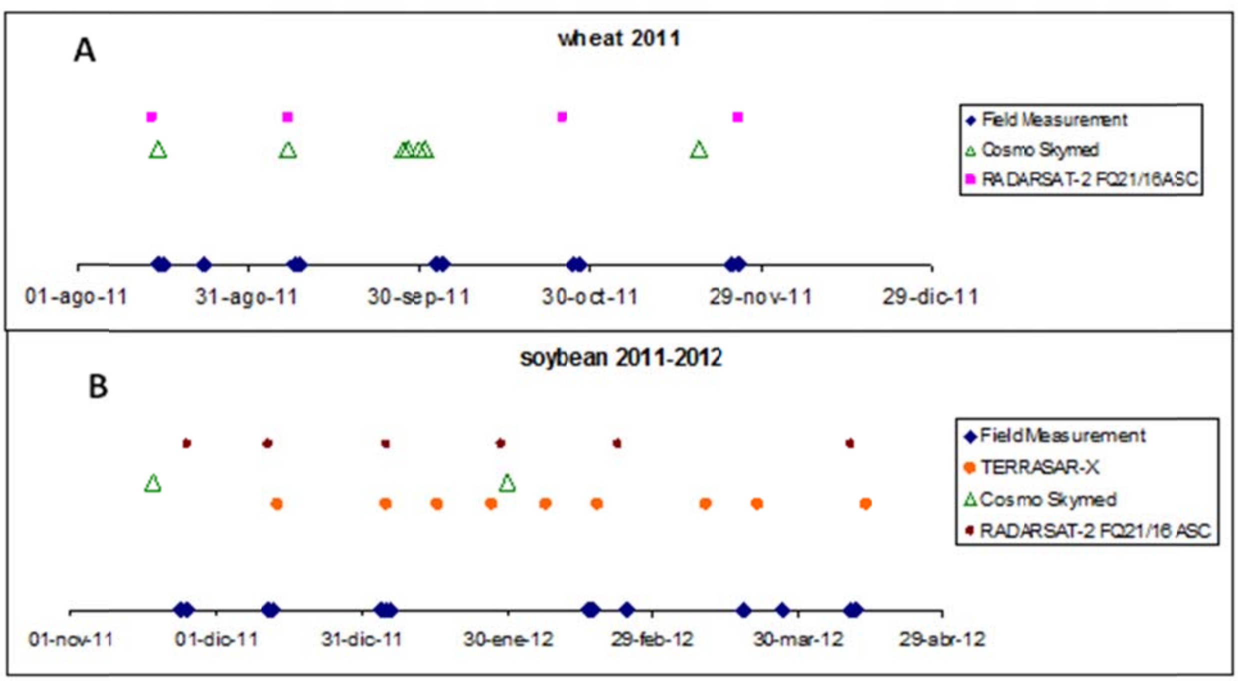
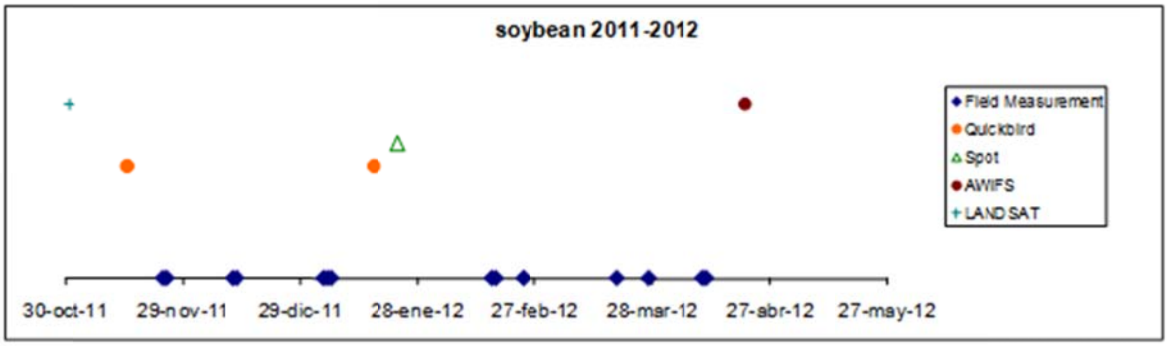


Figure 4: Dates of Intensive field measurements and High Resolution optical data acquisitions during 2011/2012 agricultural field campaign for soybean



Land use and crop type mapping:

Nearly 1000 fields were registered several times during a year during the agriculture field campaigns 2010-2011 and 2011-2012 (Figure 5). The main defined classes were:

- Wheat- Late Soybean (double crop)
- Fallow – Early Soybean
- Fallow – Maize
- Grasslands
- Pastures.

We are evaluating classification methodologies using different optical temporal and spatial resolution sensors. We are also evaluating the effects of addition of RADAR images from different bands (X, C and L). Again several difficulties occur about timing of acquisition of different sensors (End of ALOS and LANDSAT TM missions, time and frequency of acquisition of AWIFS). Also the delay between acquisition and delivery for systems like RADARSAT–2 makes timely analysis very difficult. In addition, this objective requires a larger study area and for some systems (mostly high resolution and polarimetric RADAR), a high number of scenes are required at specific times during a year to cover the whole area; these are quite difficult to obtain.

Figure 5: Fields surveyed during agricultural field campaigns 2010/2011 (Yellow) and 2011/2012 (Red)

Experience with the COVE Planning Tool

We think COVE is useful for a first approximation to know the possible potential frequency of acquisition over the study area. I would like a new version to be able to view and download exactly the area of each future acquisition. I still found some difficulties in searching future acquisitions during long times over a small area.

According to COVE outputs, for optical data there exists a very high potential frequency of acquisition (i.e. AWIFS, Quickbird), yet the probability acquiring them is much lower.

Plans for Next Growing Season

Since 2010, we started acquiring satellite data and performing regular field measurements and regional surveys over the study site for generation and calibration of yield estimation and crop mapping methodologies. Future activities are oriented to validate crop yield and crop mapping methodologies generated during JECAM initial stage (2010-2013).

Intensive field measurements were acquired with a frequency of almost 1 month during the crop growing period and regional surveys were performed at key crop growing stages. Nevertheless, the frequency of satellite data acquisition and delivery was quite variable among satellite missions from regular (less than once a month) to sporadic (few acquisitions in non optimal dates or without a regular frequency). After three years of acquiring field and satellite data, we consider that it is quite important to know before the beginning of each growing season (July or August in our region) which satellite/sensor and with which frequency of acquisition/delivery will be available. For crop monitoring or classification purposes, the availability of images during a key time window is necessary to get successful results. The availability of sporadic images at times that are not always optimal will make it very difficult to plan future field campaigns. In summary, we think that it is necessary to know before each growing season which satellite/sensor will or will not be available and with what planned frequency of acquisition/delivery.

Publications

Peer reviewed papers:

De Abelleyra D, Verón S. Comparison of different BRDF correction methods to generate daily normalized MODIS 250m time series. Remote Sensing of Environment (sent).

Presentations:

Verón S, de Abelleyra D. 2012. The use of daily MODIS reflectance data for crop monitoring at field level. Regional Workshop on Monitoring of Agricultural Production and Land Use Change. September 25-28, 2012, Buenos Aires, Argentina.

De Abelleyra D, Verón S, di Bella C. 2012. Argentine JECAM site. Regional Workshop on Monitoring of Agricultural Production and Land Use Change. September 25-28, 2012, Buenos Aires, Argentina.

De Abelleyra D, Verón S. 2011. JECAM - Joint Experiment for Crop Assessing and Monitoring. Argentina site. JECAM GEO Task AG-07-03, XV Simpósio Brasileiro de Sensoramiento Remoto. April 30-May 5, Curitiba, Brazil.

4. Belgium/France

No report received.

5. Canada

5.1 Canadian Red River Watershed

Team Leader: Dr. Heather McNairn

Members: Dr. Jiali Shang, Dr. Amine Merzouki, Anna Pacheco, Dr. Saeid Homayouni, Jarrett Powers, Grant Wiseman, Evan Rodgers

Project Objectives

The focus of research for 2012 was collection of data to support soil moisture methods development. Information is required in near-real time (within hours) for watershed and field level estimates of absolute volumetric surface soil moisture and changes in soil moisture. Regional estimates are needed to define risk due to moisture anomalies.

Site Description

The greater Red River watershed straddles the Canada-U.S. border. Approximately 75% of the Red River watershed resides within Minnesota, North Dakota and South Dakota with the remaining 25 % residing within Manitoba, Canada.

Typical field size ranges from 20-30 hectares to 50-60 hectares. Crop types are forage, pasture, canola, flaxseed, sunflower, soybean, corn, barley, spring wheat, winter wheat, rye, oats, canary seed, potatoes, field peas. Typical field rotation is cereal crop alternating with oilseed\pulse. The crop calendar is April or May to September. The climatic zone is humid continental. The Brunkild sub-watershed includes a range of soil textures including sands, coarse loamy, loamy with a strong transition to clayey. In addition to these soil textures, organic and coarse sands are also found within the greater Red River watershed. The topography is flat to gently undulating with slopes from 0% to 2%. The greater Red River watershed is similar with slopes ranging from 0% to 5% (mainly within river valleys). Soil drainage is generally poor to imperfect. Over the greater Red River watershed, soils are very poorly, poorly, imperfectly and well drained.

Earth Observation (EO) Data Received/Used

The following image data were acquired in 2012. RapidEye and SPOT-4/5 data were purchased commercially through the Canadian government National Master Standing Offer. RADARSAT-2 data were programmed and acquired through the Canadian government data allocation. TerraSAR-X data were provided through proposal LAN1575. Some DMC (August 29, September 27 and December 18) and AwiFS (August 31, September 28) data were acquired but acquisitions were late in the growing season or after crop harvest.

Table 2: Red River Imagery Acquisition Dates for Rapideye and SPOT-4/5 Sensors in 2012

RapidEye		SPOT-4/5
May, 14	July, 21	June, 23
May, 20	July, 27	June, 28
June, 4	August, 5	July, 5
June, 12	August, 19	July, 14
June, 23	August, 24	
June, 26	August, 29	
June, 28	September, 9	
July, 5	September, 14	
July, 14	September, 23	
July, 20	September, 26	

Table 3: Red River Imagery Acquisition Dates for RADARSAT-2 in 2012

RADARSAT-2 Imagery Acquisition			
April, 16	Fine-Quad Pol. Wide-2	June, 13	Fine-Quad Pol. Wide-10
April, 18	Fine-Quad Pol. Wide-3	June, 19	Standard Beam-3
April, 25	Fine-Quad Pol. Wide-8	June, 20	Fine-Quad Pol. Wide-6
April, 26	Fine-Quad Pol. Wide-10	June, 27	Fine-Quad Pol. Wide-2
May, 03	Fine-Quad Pol. Wide-6	June, 29	Fine-Quad Pol. Wide-3
May, 10	Fine-Quad Pol. Wide-2	June, 30	Standard Beam-3
May, 12	Fine-Quad Pol. Wide-3	July, 06	Fine-Quad Pol. Wide-8
May, 13	Standard Beam-3	July, 07	Fine-Quad Pol. Wide-10
May, 20	Fine-Quad Pol. Wide-10	July, 13	Standard Beam-3
May, 26	Standard Beam-3	July, 14	Fine-Quad Pol. Wide-6
May, 27	Fine-Quad Pol. Wide-6	July, 21	Fine-Quad Pol. Wide-2
June, 03	Fine-Quad Pol. Wide-2	July, 23	Fine-Quad Pol. Wide-3
June, 05	Fine-Quad Pol. Wide-3	July, 24	Standard Beam-3
June, 06	Standard Beam-3	July, 31	Fine-Quad Pol. Wide-10
June, 12	Fine-Quad Pol. Wide-8		

Table 4: Red River Imagery Acquisition Dates for TerraSAR-X Imagery for 2012

TerraSAR-X Imagery Aacuisitions			
Ascending Pass Cycle		Descending Pass Cycle	
May, 07	Stripmap/StripFar-006R	May, 08	Stripmap/ StripNear-005R
May, 18	Stripmap/StripFar-006R	May, 19	Stripmap/ StripNear-005R
May, 29	Stripmap/StripFar-006R	May, 30	Stripmap/ StripNear-005R
June, 09	Stripmap/StripFar-006R	June, 10	Stripmap/ StripNear-005R
June, 20	Stripmap/StripFar-006R	June, 21	Stripmap/ StripNear-005R
July, 23	Stripmap/StripFar-006R	July, 02	Stripmap/ StripNear-005R
August, 03	Stripmap/StripFar-006R	July, 13	Stripmap/ StripNear-005R
September, 27	Stripmap/StripFar-006R	July, 24	Stripmap/ StripNear-005R
		August, 04	Stripmap/ StripNear-005R
		August, 15	Stripmap/ StripNear-005R
		August, 26	Stripmap/ StripNear-005R
		September, 06	Stripmap/ StripNear-005R
		September, 17	Stripmap/ StripNear-005R

In situ Data

From June 7 – July 19 in situ data were collected over 55 agricultural fields and 4 forest sites. Data collected included 17 days of soil moisture (using hand-held Stevens Hydra probes), 13 days of surface roughness (using pin board profiler) and 12 days of collection of destructive biomass.

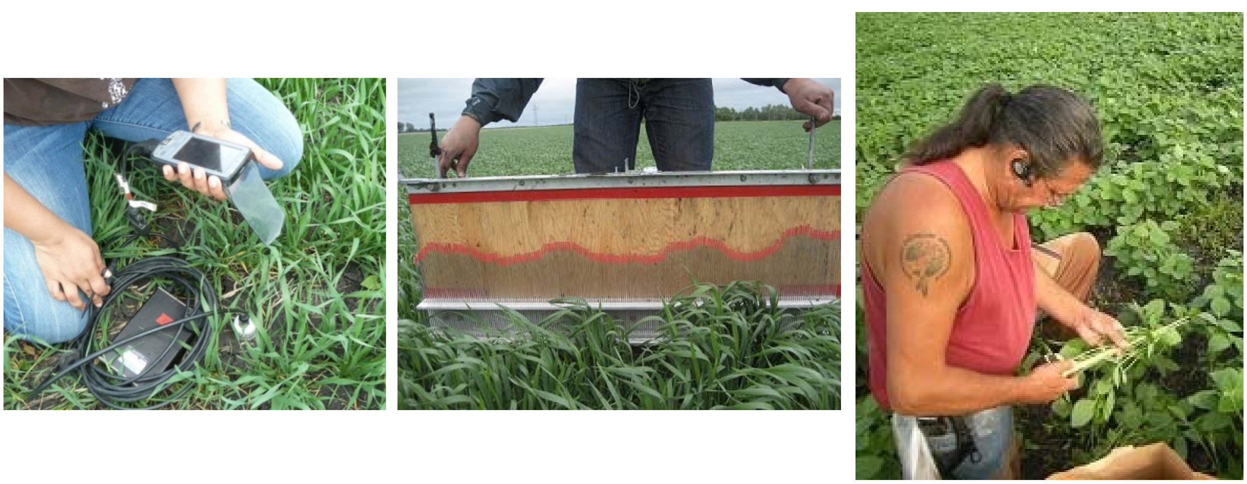


Figure 6: In situ Data Collection, Red River Site

Collaboration

The data collection campaign was led by Agriculture and Agri-Food Canada. Canadian participants included Environment Canada, University of Guelph, University of Sherbrooke, University of Manitoba and Manitoba Agriculture, Food and Rural Initiatives. Canadian participants were partially funded by the Canadian Space Agency. Participation from the U.S. included NASA and JPL, U.S. Department of Agriculture and 10 American universities.

Results

After the campaign, effort focused on calibration of the data, collation of data and creation of a geodatabase to house these data. To date, only a crop classification has been produced from the 2012 data. This classification was completed using the 3 SPOT images, 1 DMC image (August 14) (commercially purchased) and 1 RADARSAT-2 image (August 13).

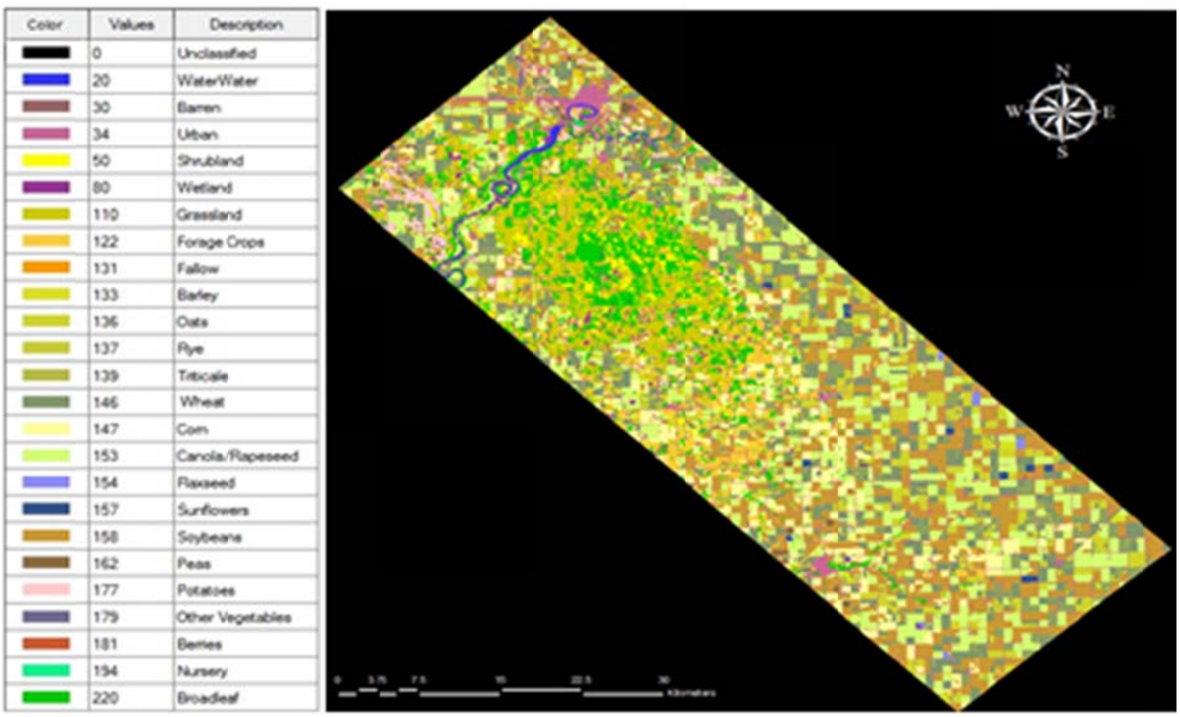


Figure 7: Crop Classification

Experience with the COVE Planning Tool

This tool was not used.

Plans for Next Growing Season

There are currently no plans to collect this scope of soil moisture data next year. Data collection will rely on use of permanent in situ soil moisture stations.

Publications

A presentation was made at the 3rd SMAP Cal/Val Workshop, November 14-16, 2012 (Oxnard, California).

5.2 Canada South Nation Watershed

Team Leader: Dr. Heather McNairn

Members: Dr. Jiali Shang, Dr. David Lapen, Dr. Angela Kross

Project Objectives

1. Monitor the South Nation Watershed in eastern Ontario Canada to augment capacity to estimate crop production properties expressed through: LAI, biomass and vegetation indices. This will require both optical and SAR satellite data acquisitions in conjunction with rigorous ground truthing activities, and geospatial yield monitoring information over corn, soybean, wheat and forage fields.
2. Use EO derived productivity indicators to demonstrate the impacts of Beneficial Management Practices (BMPs) at landscape scales and to gauge how drainage management practices can impact water use efficiency, nitrogen use efficiency, C sequestration in crop, and CO2 emissions in the rhizosphere and soil.

Site Description

The WEBs (Watershed evaluation of Beneficial Management Practices) study basin comprises a sub-'tileshed' (tile drained watershed) area of approximately 950 hectares. Mean field sizes within the WEBs basin are 4.75 hectares, with the largest reaching over 24 hectares.

Livestock and cash crops in the watershed consist of corn, soybean, wheat and forages. Field crop rotations can vary. For cropland without hay planting, crop rotations following a three year sequence: cereals-corn-soybean. Cropland with hay has a six year cycle: cereals-corn-soybean, with the following three years in hay. However, rotations can be heavily impacted by market conditions, and repetitive sequences of crops have been observed (for example corn). Farms located within the WEBs basin are generally dedicated to dairy production. Manure spreading is normally done in either late summer or early fall. Conventional tillage, which is the dominant tillage practice in the study area, typically consists of spring cultivation and fall ploughing.

Situated in a cool temperate humid continental climate in eastern Ontario Canada, mean yearly air temperatures are approximately 6.2ºC, total yearly precipitation is approximately 963 mm, and total yearly rainfalls are approximately 771. Dominant soils at the WEBs site are Bainsville silt loams, characterized by layered silt and fine sand, overlying clayey deposits, with poor natural drainage. The lower hydraulic conductivity clayey soils lay beneath top soils at approximately 1.0–1.5m depth. Local slope of the study area is generally <1%.

EO Data Received/Used

The following image data were acquired in 2012. Twelve RapidEye images were purchased commercially through the Canadian government National Master Standing Offer. RADARSAT-2 data (9 dates) were programmed and acquired through the Canadian government data allocation. TerraSAR-X data (6 images) were provided through an existing proposal with DLR. Some DMC (August 29, September 27 and December 18) data were acquired but acquisitions were late in the growing season or after crop harvest.

Table 5: Summary of South Nation Data Acquisitions 2012

#	Sensor	Date	SensorMode	Polarization Mode	Polarization channels	Beam
1	TerraSAR-X	07/06/2012	Stripmap	Dual	VV+VH	stripNear_013R
2	TerraSAR-X	18/06/2012	Stripmap	Dual	VV+VH	stripNear_013R
3	TerraSAR-X	29/06/2012	Stripmap	Dual	VV+VH	stripNear_013R
4	TerraSAR-X	21/07/2012	Stripmap	Dual	VV+VH	stripNear_013R
5	TerraSAR-X	12/08/2012	Stripmap	Dual	VV+VH	stripNear_013R
6	TerraSAR-X	23/08/2012	Stripmap	Dual	VV+VH	stripNear_013R
1	Radarsat2	22/06/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ3W
2	Radarsat2	16/07/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ3W
3	Radarsat2	26/07/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ13W
4	Radarsat2	19/08/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ13W
5	Radarsat2	02/09/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ3W
6	Radarsat2	12/09/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ13W
7	Radarsat2	26/09/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ2W
8	Radarsat2	26/09/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ3W
9	Radarsat2	02/07/2012	Fine Quad Wide	Quad	VV, VH, HH, HV	FQ13W
1	RapidEye (RE2)	30/05/2012				
2	RapidEye (RE5)	17/06/2012				
3	RapidEye (RE5)	21/06/2012				
4	RapidEye (RE2)	28/06/2012				
5	RapidEye (RE1)	11/07/2012				
6	RapidEye (RE3)	18/07/2012				
7	RapidEye (RE5)	29/07/2012				
8	RapidEye (RE1)	04/08/2012				
9	RapidEye (RE1)	18/08/2012				
10	RapidEye (RE5)	22/08/2012				
11	RapidEye (RE2)	29/08/2012				
12	RapidEye (RE3)	13/09/2012				

In situ Data

During the 2012 growing season, a variety of crop production variables were collected at weekly intervals including: leaf area index (using LAI2000 and hemispherical photos), reflectance (using Crop Scan), crop height, relative chlorophyll content (using SPAD), phenology and soil moisture (using Theta

Probes). The data were collected at corn, soybean and forage fields under both controlled and uncontrolled drainage management.

Collaboration

The data collection campaign was a collaboration among several Agriculture and Agri-Food Canada (AAFC) research scientists (Dr. McNairn, Lapen and Shang). Dr. Angela Kross, a visiting scientist at AAFC, is leading the data collection and analysis.

Results

A variety of vegetation indices were derived from the RapidEye imagery, including the: normalized difference vegetation index (NDVI), simple ratio (SR), red edge normalized difference vegetation (NDVIre), red edge simple ratio (SRre), modified triangular vegetaton index (MTVI2), and red edge triangular vegetation index (RTVI). Landsat and SPOT4/5 images were used to derive the normalized difference water index (NDWI) and the moisture stress index (MSI). The response of crops to controlled and uncontrolled tile drainage at the field level was assessed and relationships between the vegetation indices and the ground measured variables were established. Currently we are estimating the leaf area index at the watershed level between 2005 and 2012 using satellite derived vegetation indices. LAI is derived from VIs using a modified version of the Beer's law (calibration of function through curve fitting of ground measured LAI and satellite derived VIs). Leaf area index maps will allow us to assess the impact of the drainage systems at the watershed level.

The radar images are used for classification of the crop types in the SouthNation WEBS study area. Currently we are using the TerraSAR-X data for the classification. The objectives are to:

1. evaluate the potential of radar data only for classification
2. compare the performance of two speckle filter (multi temporal filer versus spatial filter)
3. establish a minimum number of dates for the classification of crop early in the season.

Experience with the COVE Planning Tool

This tool was not used.

Plans for Next Growing Season

2012 conditions were very dry and thus minimal impacts of controlled tile drainage were observed. Consequently, a repeat of the data collection strategy for 2012 is planned for the 2013 field season.

Publications

No presentations or publications have been delivered thus far.

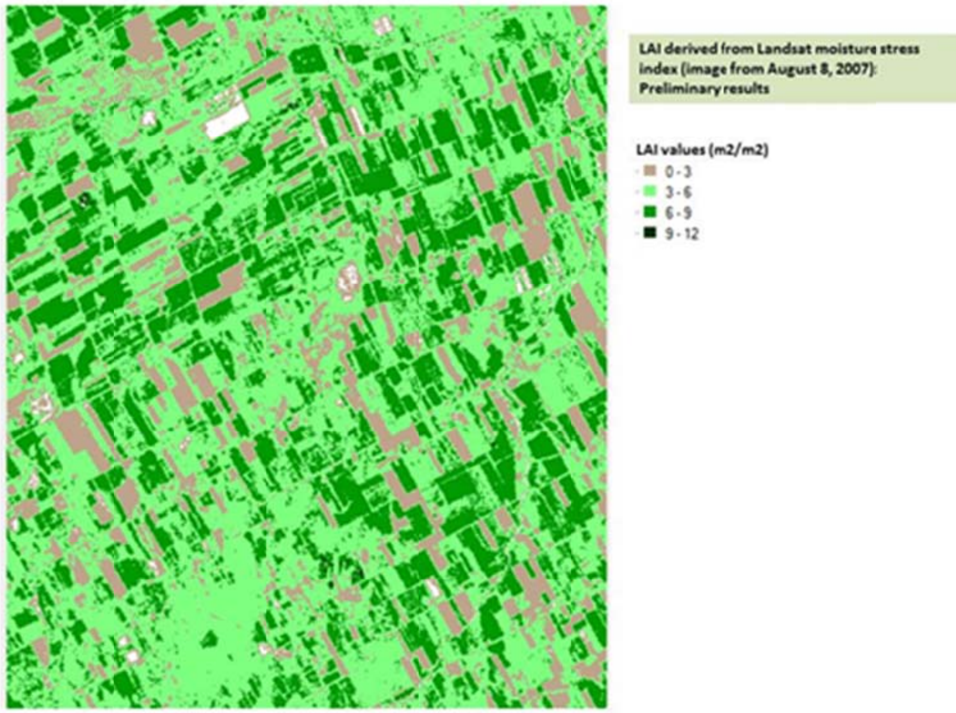


Figure 8: LAI Derived from Landsat Stress Index, Preliminary Results

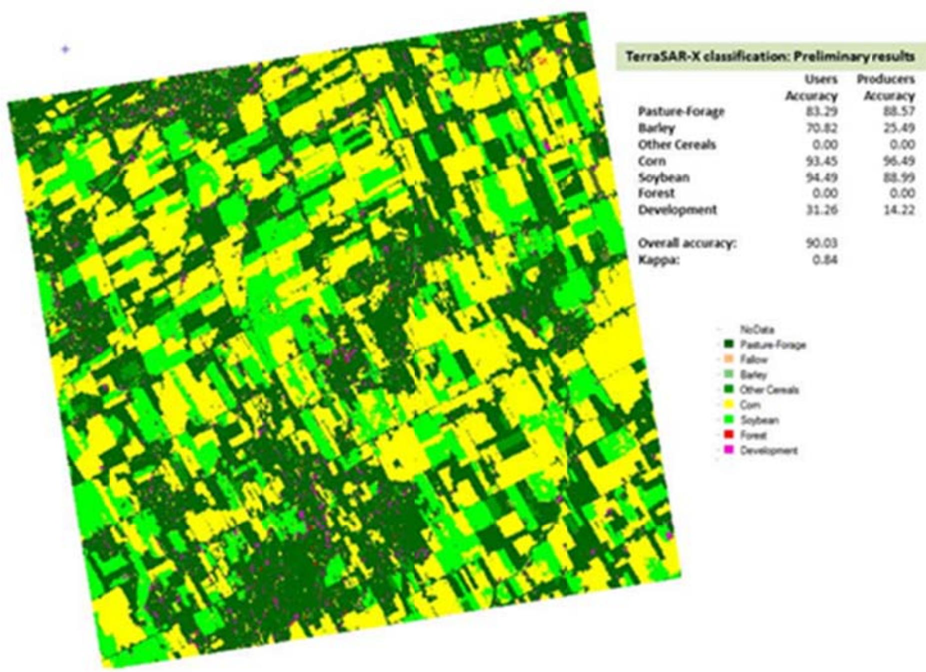


Figure 9: TerraSAR-X Classification, Preliminary Results

6. China

6.1 Anhui

No report received.

6.2 Guangdong

No report received.

6.3 Heilongjiang

Team Leader: Wu Bingfang

Members: Meng Jihua, Zhang Miao, Zeng Hongwei, Zou Wentao, Dong Taifeng, Li Zhongyuan, Liu Guoshui, Chang Sheng, Inkendo J.K., You Xingzhi, Xu Jin, Zheng Yang

Project Objectives

The original objectives of the site have not changed.

- Crop identification and Crop Area Estimation
  - Support vector machine, Decision tree, Object-oriented method
  - Multi-configuration SAR data
  - Integration of Optical and SAR data
  - Statistical analysis
- Crop Condition/Stress
  - Crop Growing Conditions Over the Growing Season
  - NDVI, NDWI, Vegetation condition index, temperature condition index, crop water stress index, etc.
- Estimation of Biophysical Variables
  - NDVI
  - fAPAR, LAI-Radiation transfer model
- Yield Prediction and Forecasting
  - Biomass-modified CASA model
    - Water stress factor, temperature stress factor
  - Harvest index
    - Regression analysis of time series NDVI
- Crop residue cover and tillage mapping
  - crop residue cover
  - Tillage-classification
- Phenological Events

- Logistic regression

Site Description

- Location
  - Top-Left: Latitude: 48.286°N Longitude: 126.831°E
  - Bottom-Right: Latitude: 48.046°N Longitude: 127.239°E
- Topography: Plain
- Soils: Soils in the study site are mainly chernozem.
- Drainage class/irrigation
  - The soil drainage class is submersion of basins. Almost no irrigation infrastructure can be found in this JECAM site.
- Crop calendar
  - Crops in the study area are dominated by soybean, spring corn and spring wheat.
  - The crop calendar for spring wheat is from mid-April to late July, for soybean is from mid-May to end of September and for maize is from mid-May to late October.
  - Field size: Typical field size is 5 to 20 ha.
- Climate and weather
  - The climatic zone is cold temperate continental climate. Mean annual precipitation is about 555 mm, concentrated from July to September.

Figure 10: Heilongjiang Agricultural Fields

EO Data Received/Used

MODIS:

- 21 scenes, from April 15th to September 30th, 2012
- H26V04, 250m/500m/1km
- Level 2
- We had no difficulty in acquiring MODIS data, nor in processing and using MODIS data; however, the resolution is too coarse for the study site.

Radarsat-2:

- 2 scenes, August 5th and 9th, 2012, FQ11&FQ28, Fine Quad Polarization
- We submitted an order for 8 scenes Radarsat-2 images but we only got 2 scenes. Our other orders were bumped by higher priority orders.
- We used the ESA SAR toolbox (NEST 4B) to process Radarsat-2 data and we have no difficulty in processing it yet.

TerraSAR-X:

- 1 ScanSAR, 1 Stripmap, August 4th and 6th, 2012, scan_006, stripFar_014, Level 1B Product
- We submitted an order for 8 scenes TerraSAR-X images but we only got 2 scenes. Our other orders were bumped with by higher priority orders.
- We used the ESA SAR toolbox (NEST 4B) to process TerraSAR-X data but it does not support the data type we acquired. So we have not processed the TerraSAR-X data yet.

China Environmental Satellite (HJ-1 CCD, HJ-1 IRS):

- China Centre for Resource Satellite Data and Applications (CRESDA) Optical
- 10 scenes of HJ-1 CCD images, 5 scenes of HJ-1 IRS, Level 2 Product
- From mid-April to late September, 2012
- CCD: 448-56/446-56/446-53
- IRS: 444-56/446-56/450-56/448-57/450-58
- We no difficulty in acquiring HJ-1 data, nor did have any difficulty in processing and using HJ-1 data yet.

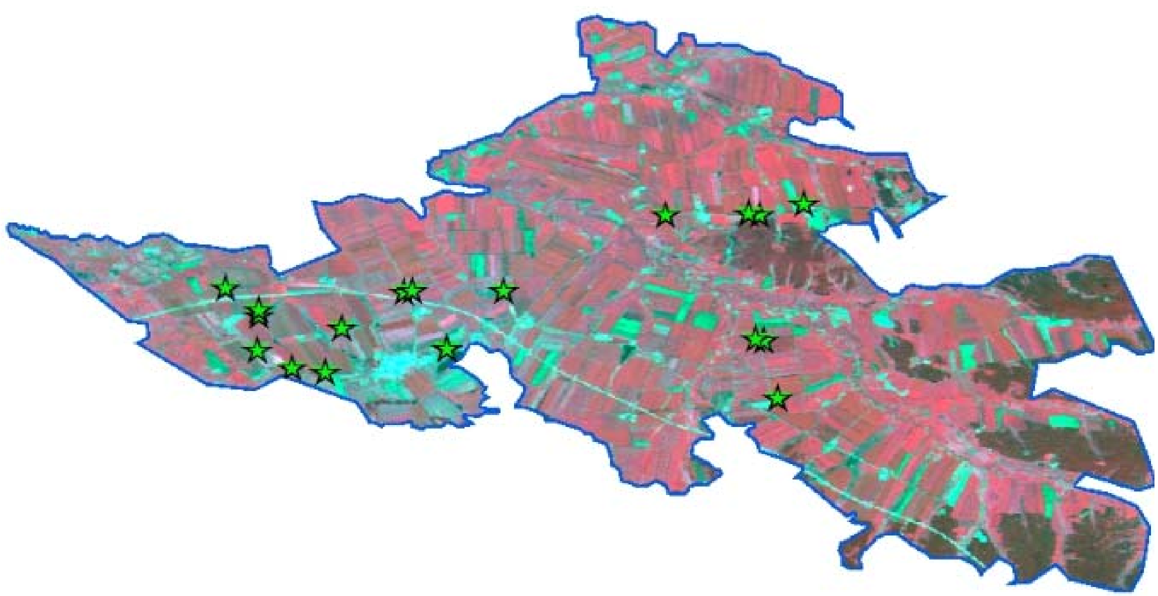


Figure 11: Sample HJ-1 Image of Heilongjiang Site

In situ Data

The main variables measured and the instruments we are using are shown in Table 6.

Table 6: Heilongjiang In situ Data

Main variables	Instruments or processing method
Spectral reflectance	HR-768 portable spectroradiometer (Spectra Vista Corporation, NK, USA)
FPAR	SUNSCAN Canopy Analysis system
LAI	LAI 2000
Fractional of vegetation cover	Fisheye camera
Dry amount of above ground biomass	Oven dried and weight
Yield	Oven dried and weight
Harvest index	Calculated by yield and AGB
Density/canopy height	Tape measured
Chlorophyll content of leaf	SPAD 502 Plus

All the variables were measured once a month from April to September except for above ground biomass (AGB), yield and harvest index. AGB, yield and harvest index were measured once a year.

The biggest challenge is weather conditions during the field observations. The spectral reflectance should be measured on a sunny, windless day. Weather conditions in the China Heilongjiang site were always changing. It is sunny in the morning, but cloudy at noon, and this may influence measurements of field spectral and FAPAR.

Collaboration

Until now, we did not collaborate with other JECAM sites over the China Heilongjiang site. But we have a collaborative project with the Hongxing Farm focusing on crop monitoring and precision farming. They helped us to process the crop samples and measured biochemical variables. We can share some of the field measurements data with each other.

We are going to collaborate with the Argentina JECAM site over China Heilongjiang site starting from April 2013. We will do field experiment over the site together with the researchers working on the Argentina JECAM site.

Figure 12: Pictures of the Heilongjiang site

Results

Crop condition and crop stress

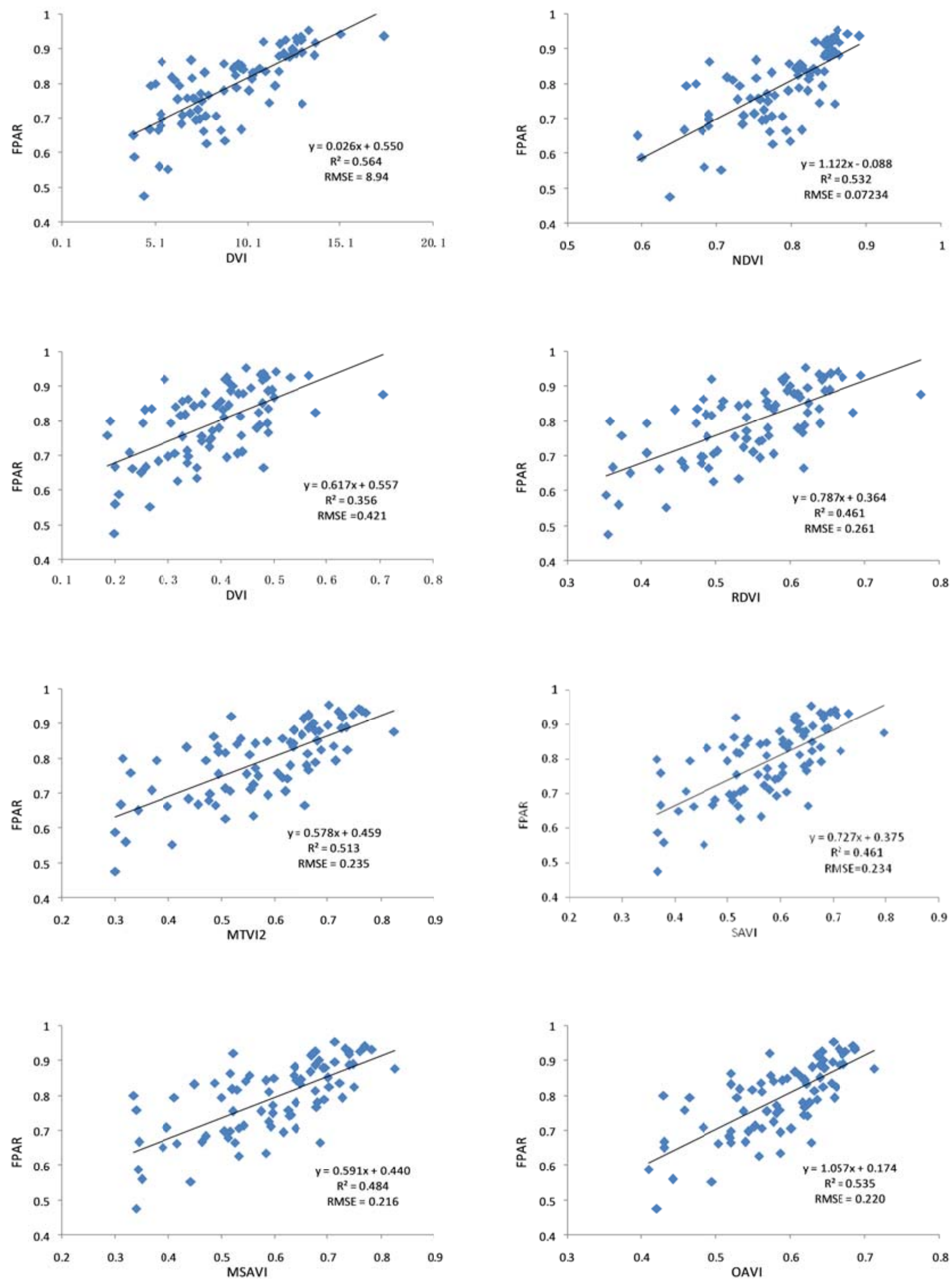
Based on China Environmental Satellite (HJ-1) CCD and IRS data, Normalized difference vegetation index was derived and compared with that of last year to generate crop condition map for Hongxing Farm. Figure 13 shows the crop condition of the JECAM site on July 13th, 2013. Water stress and nitrogen content of the crop canopy over the Hongxing Farm were also estimated.

Figure 13: Crop Condition of Heilongjiang Site on 13 July 2013

FPAR versus Different Vegetation Indices

According to the band configuration of HJ -1B CCD data and field measured spectrum, NDVI, PVI, EVI, AgNDVI, CIgreen, DVI, RDVI, MTVI2, SAVI, MSAVI, OSAV and EVI2 were derived. The relationships between those vegetation indices and FPAR were analyzed and are shown in Figure 14. All those vegetation indices have a strong linear correlation with FPAR. Among those indices, NDVI, DVI and AgNDVI were the three indices that were best correlated with FPAR. According to this result, NDVI, DVI and AgNDVI were the best three indices to estimate FPAR.

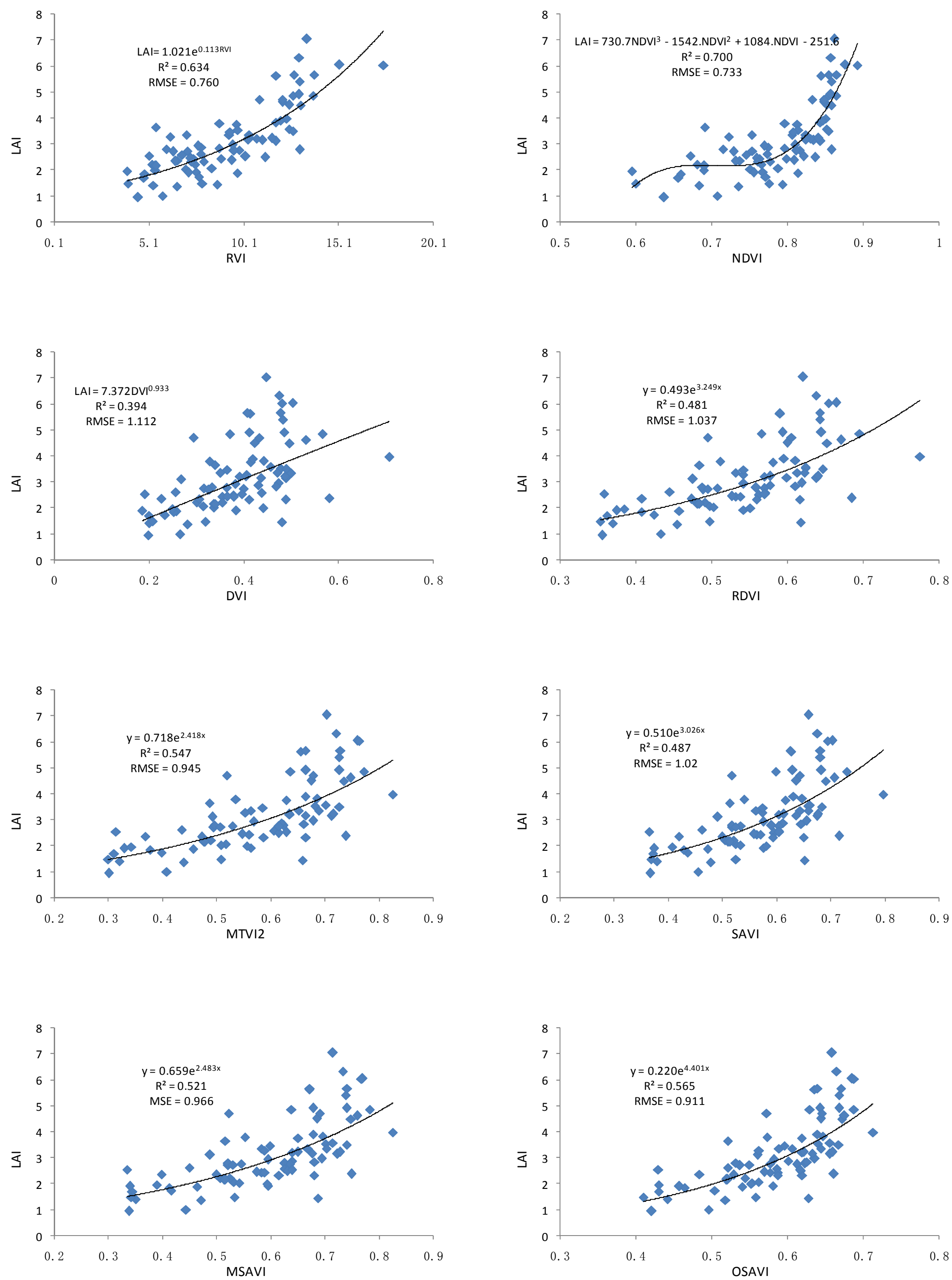
Figure 14: Relationships between FPAR and Different Vegetation Indices



LAI vs. different vegetation indices

Relationships between those vegetation indices and LAI were analyzed and are shown in Figure 15.

Figure 15: Regression Analysis between Different Vegetation Indices and Leaf Area Index

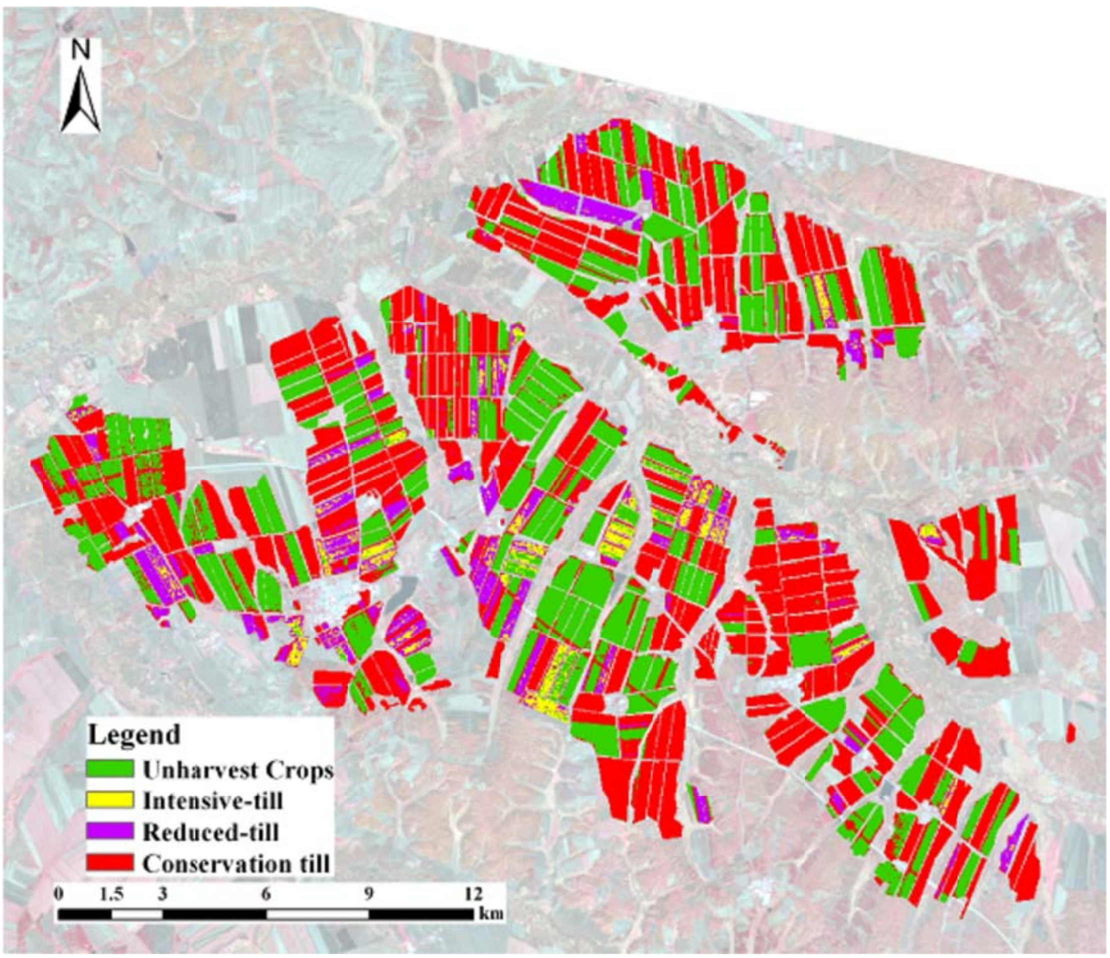


According to the regression analysis results, CIgreen was best correlated with LAI linearly, with highest determination coefficient and lowest root mean square error. CIgreen was calculated by reflectance of the green band and the near infrared band, which enhance the information of green vegetation.

Tillage mapping

Crop residue cover for Hongxing Farm was estimated using a linear model with SASI and summarized into three categories, corresponding to intensive (<15% residue cover), reduced (15–30% cover) and conservation (>30% cover) tillage.

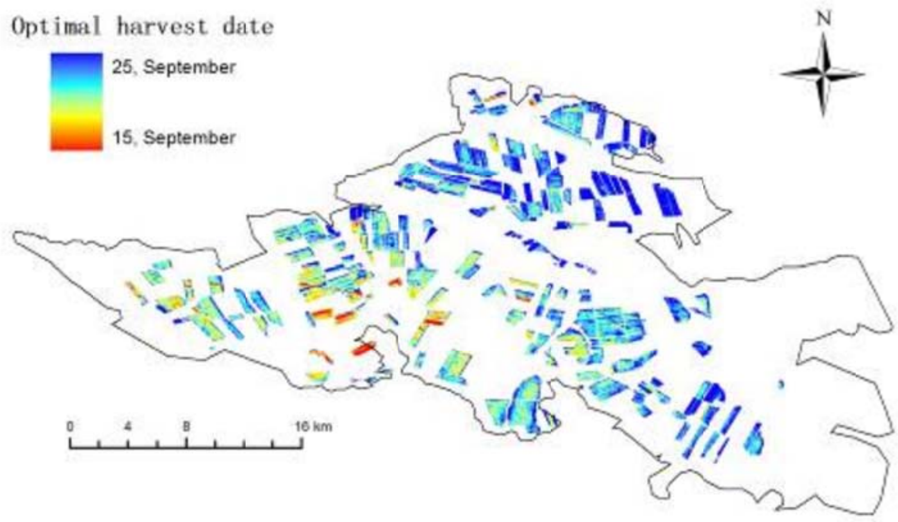
Figure 16: Heilongjiang Tillage Mapping



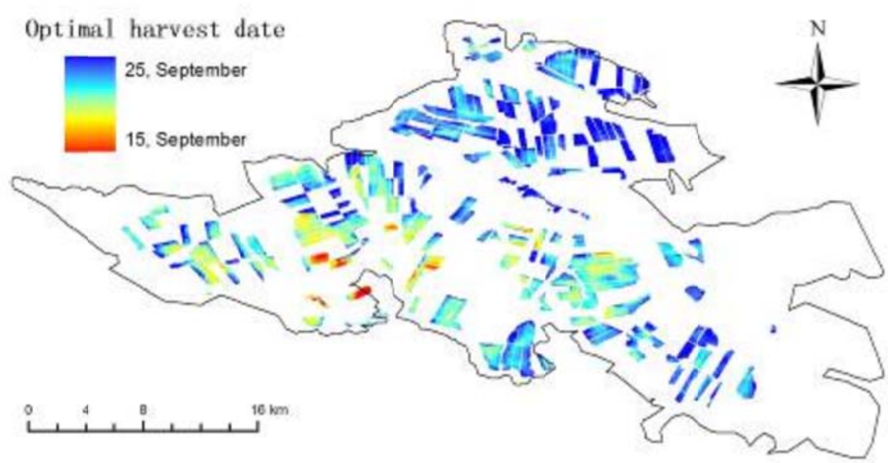
Crop Maturation Date

The models for optimal soybean harvest date prediction were developed through the linear regression between remote sensing indicators and observed optimal harvest date. NDVI and NDWI were used to predict optimal soybean harvest date. The maps of optimal harvest date are shown in Figure 17.

Figure 17: Predicted Optimal Soybean Harvest Date Maps (a: from NDVI; b: from NDWI)



(a)



(b)

<u>Experience with the COVE Planning Tool</u>

We did not use COVE Planning Tool to acquire or order EO data. But I think it will be useful in planning the acquisitions. So we are interested in having someone take a short COVE training course at the next JECAM meeting.

<u>Plans for Next Growing Season</u>

We hope to carry out field experiments synchronous with some satellite acquisitions in 2013. In 2013 and the future, we will measure same variables as those in 2012 and we are also planning to measure some new variables including air temperature, land surface temperature, soil water content, leaf water content and nitrogen content of the crop canopy.

In 2012, we tried to acquire some optical images, such as Rapideye and Worldview-2 images over the study site, but we failed to obtain them because our orders were bumped by higher priority orders. We anticipate ordering some high resolution optical data including Rapideye, Worldview-2, and UK-DMC2 in 2013 and the future.

We had some difficulty in processing TerraSAR-X data with the type SE_SM_D because the NEST 4B software can only process TerraSAR-X SSC products. So we hope to acquire TerraSAR-X SSC products in 2013 and the future.

Publications

Zhang, Miao; Wu, Bingfang; Meng, Jihua; Li, Qiangzi; Dong, Taifeng; , "Evaluation of spectral angle index from Landsat TM image for crop residue cover estimation," Geoscience and Remote Sensing Symposium (IGARSS), 2012 IEEE International , vol., no., pp.5073-5076, 22-27 July 2012 doi: 10.1109/IGARSS.2012.6352470.

Dong Taifeng, Wu Bingfang, Meng Jihua, Li Qiangzi, Zhang Miao. Study of a Vegetation Index Based on HJ CCD data's top-of-atmosphere reflectance and FPAR Inversion. Accepted by the 35th International Symposium on Remote Sensing of Environment (ISRSE35), April 2013, China, Beijing.

Cao Xin, Li Qiangzi, Zheng Xinqi. Extract effect of segmentation scale on orient-based crop identification using HJ CCD data in Northeast China. Accepted by the 35th International Symposium on Remote Sensing of Environment (ISRSE35), April 2013, China, Beijing.

Meng Jihua, Dong Taifeng, Zhang Miao, You Xingzhi, Wu Bingfang, 2013. Predicting Soybean Mature Date with Satellite Data. Accepted by the 9th European Conference on Precision Agriculture 2013 (ECPA2013, Lleida, Catalonia, Spain).

Zhang Miao. Introduction to China JECAM sites, Regional Workshop on Monitoring of Agricultural Production-Potentials and limitations of remote sensing, September 27th, 2012, Argentina, Buenos Aires. (Presentation)

Wu Bingfang. CropWatch: Introduction, Regional Workshop on Monitoring of Agricultural Production-Potentials and limitations of remote sensing, September 27th, 2012, Argentina, Buenos Aires. (Presentation)

6.4 Jiangsu

Team Leader: Shao Yun

Members: Kun Li, Brian Brisco, Fengli Zhang, Long Liu, Zhi Yang, Weiguo Li

Project Objectives

The original objectives of the site have not changed.

- Crop identification and Crop Area Estimation

First, identify rice fields with polarimetric responses and scattering mechanisms. Second, remove the influence of the ridge of rice fields, and estimate the rice acreage accurately.

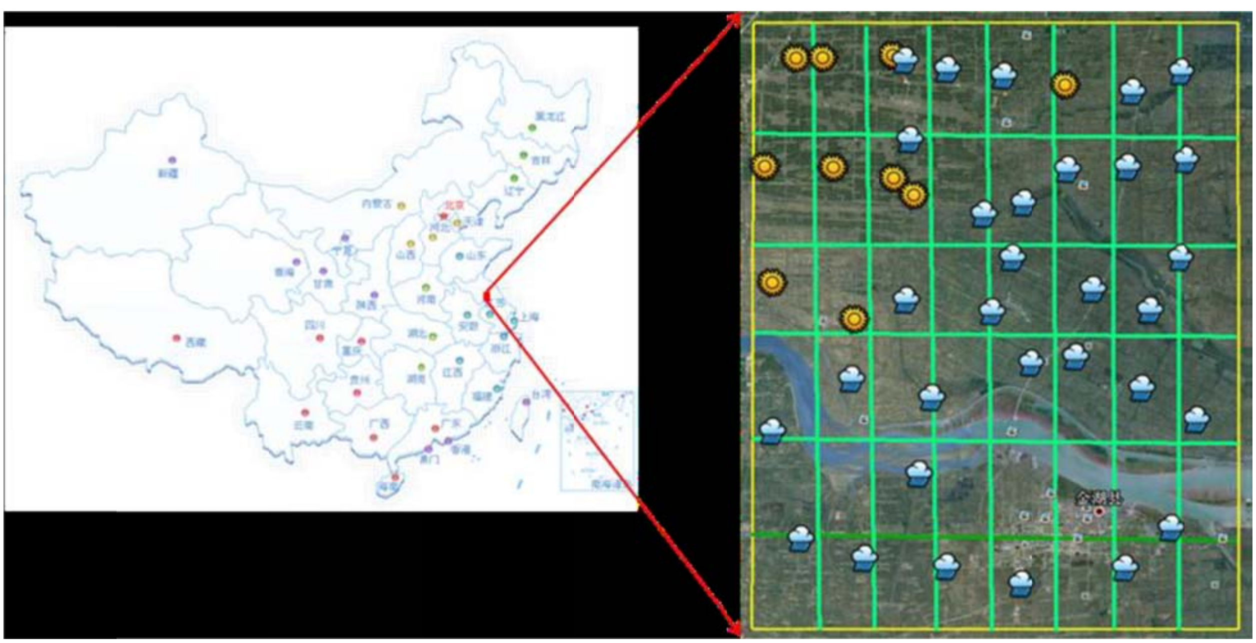
- Yield Prediction and Forecasting

A quantitative relationship between polarization variables and rice key parameters (biomass, LAI) will be established. Then, a crop model, taking into account the variation of the time - domain and environmental stress, will be employed for rice yield prediction.

Site Description

The test site is located in Jinhu (33°15'22.33"N - 32°58'35.00"N, 118°49'39.97"E - 119° 6'51.67"E), Jiangsu Province, east of China, with area of $600km^2$ (Figure 18). The terrain is flat, with the average altitude mostly less than 10m. The climate belongs to the transition region between the subtropical and the temperate zone, with four distinct seasons. The annual average temperature of the test site is about

Figure 18: Location of Test Site and the Distribution of the Sample Plots, Cloud and Sun, Mean Transplant and Direct-planting Rice Fields Respectively



13 to 16℃. The average precipitation is about 800 to 1200 mm every year, and more than half of the precipitation occurs from June to September. The sunshine hours can be up to 2400 every year. The soil type of this region is mostly yellow brown clay, which is favourable for rice plant development. The main paddy varieties in this area are hybrid and japonica rice. There is one rice crop a year, with the growth cycle about 150 days, from early May to late October.

There are two rice planting methods in the test site, transplanting and direct-sowing, which will produce two different rice field structures (Figure 19) and have a certain impact on rice yields. The size of rice field parcels is 1700m^2 or so. In this study, forty-one sample plots were selected in the test site, covering twenty-nine transplanting fields and twelve direct-sowing fields. The distribution of these sample plots is also showed in Figure 13.

Figure 19: Rice Fields in the Jiangsu Test Site

(a) Transplanting (b) Direct-sowing

EO Data Received/Used

From late June to early November 2012, twelve RADARSAT-2 images were acquired (purchased from MDA), including eleven polarimetric images and one Multi-look Fine image. The details of the SAR data are displayed in Table 7. In cooperation with CCRS (Canada Centre for Remote Sensing), we acquired seven compact - pol simulated datasets, simulated from the polarimetric RADARSAT-2 data (red in Table 7) in order to explore the potential of compact - pol SAR in rice mapping and monitoring.

In situ Data

During the growing season in 2012, 12 ground campaigns were conducted.

- Vegetative stage: about 85 days, including germination, seedling, tilling, and jointing stages, 5 times field work;

Dates	Mode	Product	Resolution (m)		Image Size (km^2)	Incidence Angle (°)	Look	Polarization
			Range	Azimuth				
6/27/2012	FQ20W	SLC	5.2	7.6	565	38.89	1	HH/HV/VH/VV
7/11/2012	FQ9W	SLC	5.2	7.6	571	27.53	1	HH/HV/VH/VV
7/21/2012	FQ20W	SLC	5.2	7.6	565	38.89	1	HH/HV/VH/VV
7/28/2012	MF22W	SLC	3.1	4.6	603	31.73	1	HH
8/4/2012	FQ9W	SLC	5.2	7.6	571	27.53	1	HH/HV/VH/VV
8/14/2012	FQ20W	SLC	5.2	7.6	565	38.89	1	HH/HV/VH/VV
8/28/2012	FQ9W	SLC	5.2	7.6	571	27.53	1	HH/HV/VH/VV
9/7/2012	FQ20W	SLC	5.2	7.6	565	38.89	1	HH/HV/VH/VV
9/21/2012	FQ9W	SLC	5.2	7.6	571	27.53	1	HH/HV/VH/VV
10/15/2012	FQ9W	SLC	5.2	7.6	571	27.53	1	HH/HV/VH/VV
10/25/2012	FQ20W	SLC	5.2	7.6	565	38.89	1	HH/HV/VH/VV
11/8/2012	FQ9W	SLC	5.2	7.6	571	27.53	1	HH/HV/VH/VV

Table 7: Technical Parameters of RADARSAT-2 Data Acquired in 2012

- Vegetative and reproductive growth overlap stage: about 35 days, including booting, heading and flowering stages, 4 times field work;
- Productive stage: about 30 days, including milk, soft dough, and maturity stages, 3 times field work.

Field data was collected from three representative rice plants in each sample plot, including variety, crop calendar, phenological stage, plantation geometry, plant structural information (plant height, number of leaves, leaf length and width, number of stems and of ears), plant biomass (dry and wet weight). The details are listed in Table 8.

Table 8: List of Parameters Collected in the Field Campaign

<table>
<tr><th colspan="2">Category</th><th colspan="2">Parameters</th></tr>
<tr><td colspan="2">Geographic information</td><td colspan="2">Latitude and longitude, plots border, altitude, terrain, etc.</td></tr>
<tr><td colspan="2">Meteorological information</td><td colspan="2">Temperature, humidity, wind, and precipitation, etc.</td></tr>
<tr><td colspan="2">Cultural practices</td><td colspan="2">Planting time, the growth stage, planting (transplanting, direct-planting), rice varieties</td></tr>
<tr><td></td><td></td><td>Geometrical structure parameters</td><td>Physiological parameters</td></tr>
<tr><td rowspan="4">Rice</td><td>The whole plant</td><td>Height, diameter of bunch, plantation geometry (bunch spacing, line spacing, the number of plants per bunch)</td><td>Leaf area index, fresh weight, water content</td></tr>
<tr><td>Stem</td><td>Length, internal diameter, external diameter, inclination</td><td>Fresh weight, dry weight, water content</td></tr>
<tr><td>Leaf</td><td>Length, width, thickness, inclination, the height of leaf node, the height of leaf vertex, the height of leaf tailed-point, the distance between the leaf node and tailed-point, the number of leaves per plant</td><td>Fresh weight, dry weight, water content</td></tr>
<tr><td>Ear</td><td>Length, the diameter of ear, inclination, the height of ear node, the height of ear vertex, the height of ear tailed-point, the distance between the ear node and tailed point, the number panicles of per ear</td><td>Fresh weight, dry weight, water content</td></tr>
<tr><td rowspan="2">Underlying surface</td><td>Water</td><td>Depth</td><td></td></tr>
<tr><td>Soil</td><td>Surface roughness, soil texture</td><td>colour, master horizon, water content, bulk density, organic carbon%, pH in water, cation exchange capacity, total nitrogen%, etc.</td></tr>
</table>

<u>Collaboration</u>

We have not been approached to participate in a collaborative project with other sites.

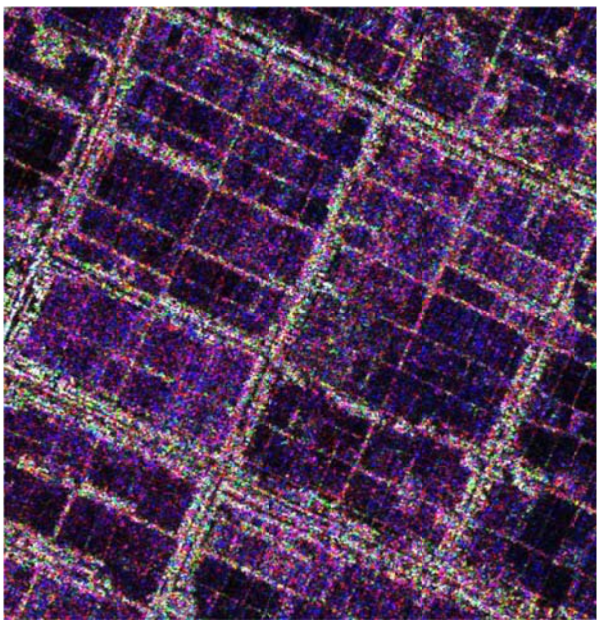
Results

In mid-November 2012, all the field work had been completed. Data process and analysis have already begun. The preliminary results are as follows:

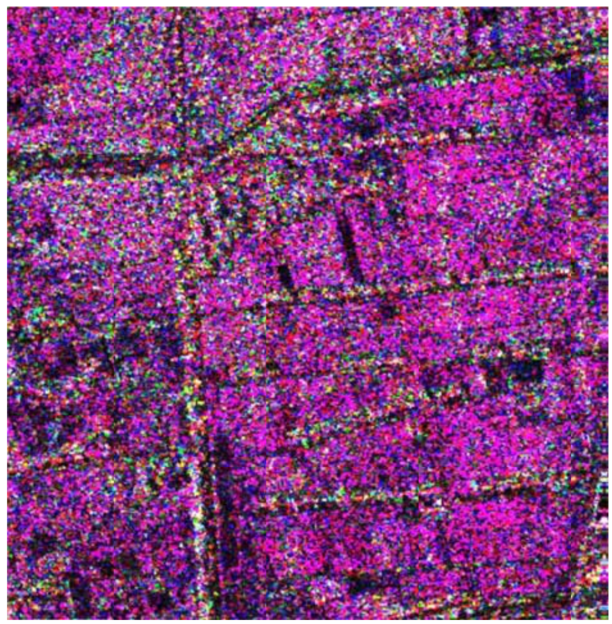
1）Rice Fields in Polarimetric SAR Image

Figure 20 shows the rice fields with transplanting and direct-sowing in a polarimetric SAR image acquired on June 27, 2012. It can be seen that two kinds of rice fields, transplanting rice and direct-sowing rice, show up very differently in a polarimetric SAR image.

Figure 20: Rice fields in Polarimetric SAR Image (R=HH, G=HV, B=VV; 6/27/2012, Seedling stage)



Transplanting Rice

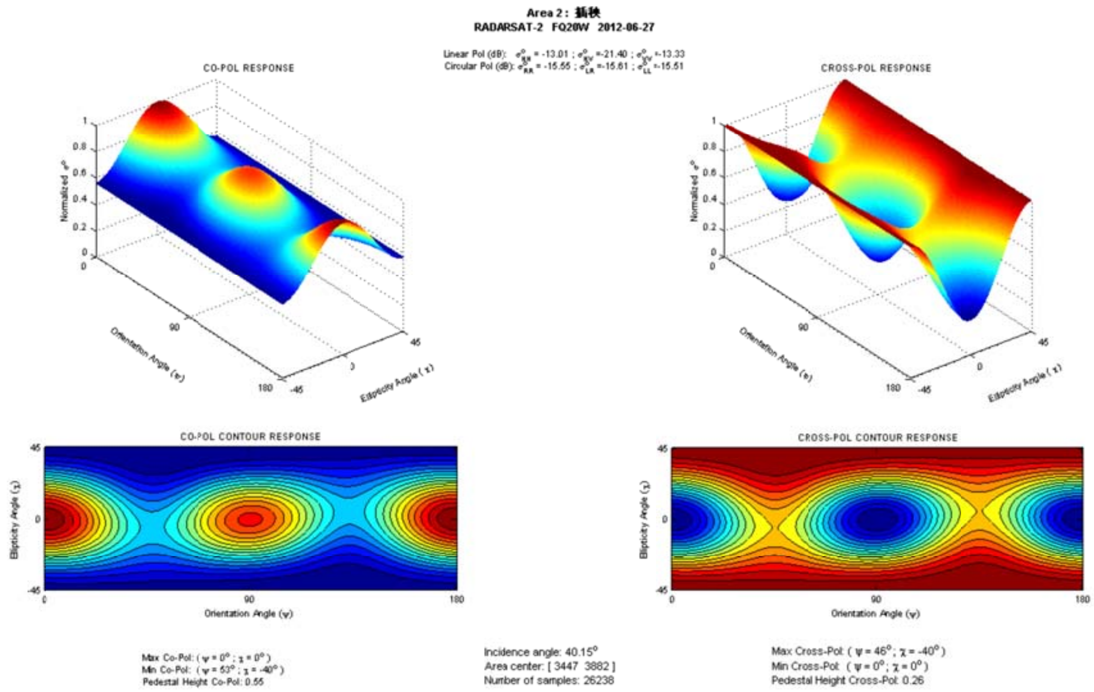


Direct-sowing Rice

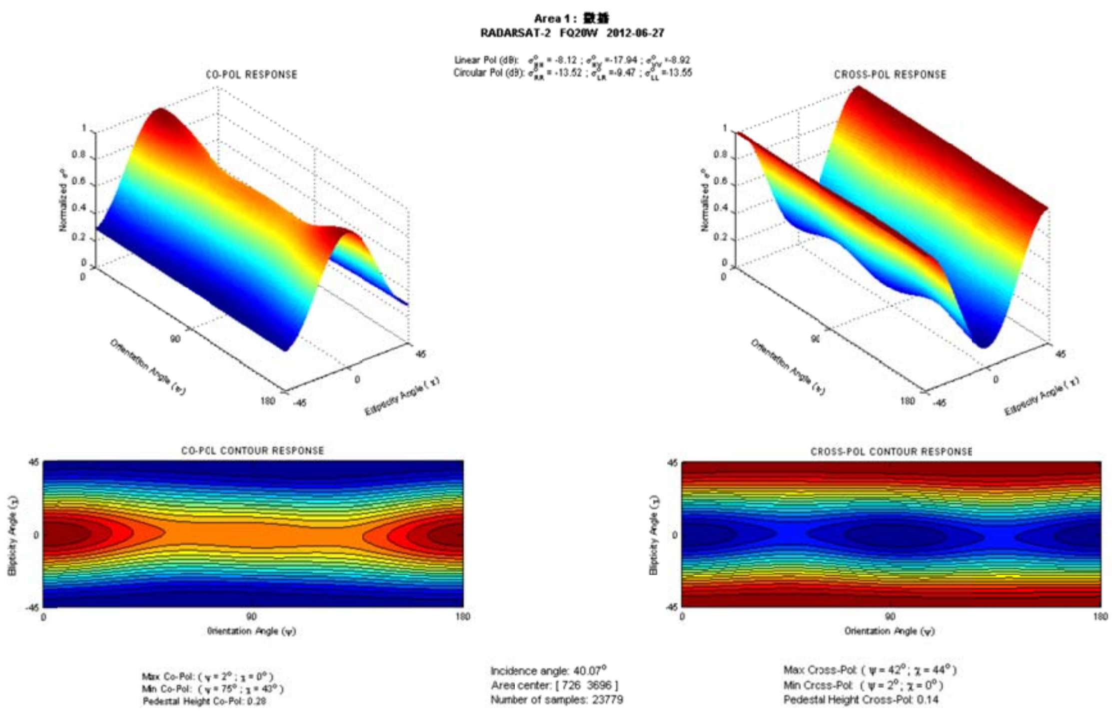
2）Polarimetric Analysis

The polarimetric signatures of transplanting rice and direct-sowing rice are presented in Figure 21. Figure 22 shows the distributions of the two kinds of rice fields in H-Alpha plots.

Figure 21: Polarization Signatures

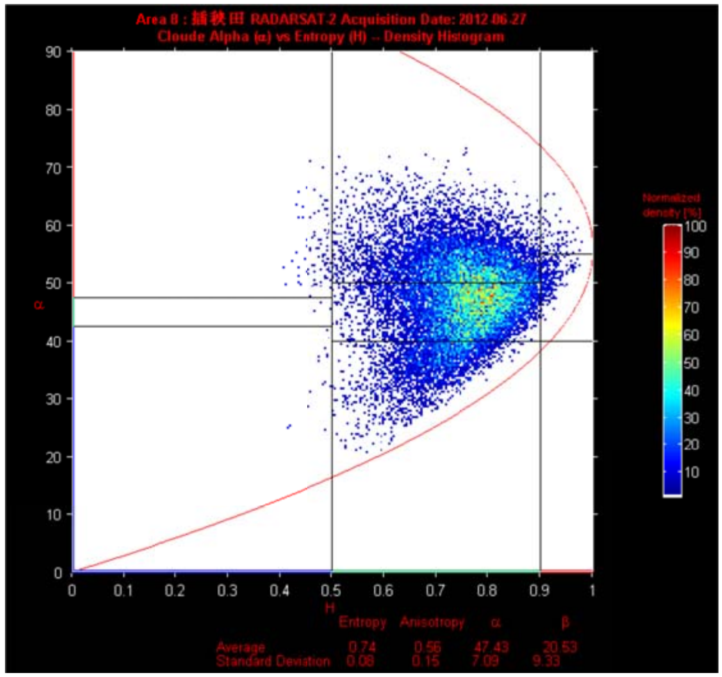


Transplanting Rice

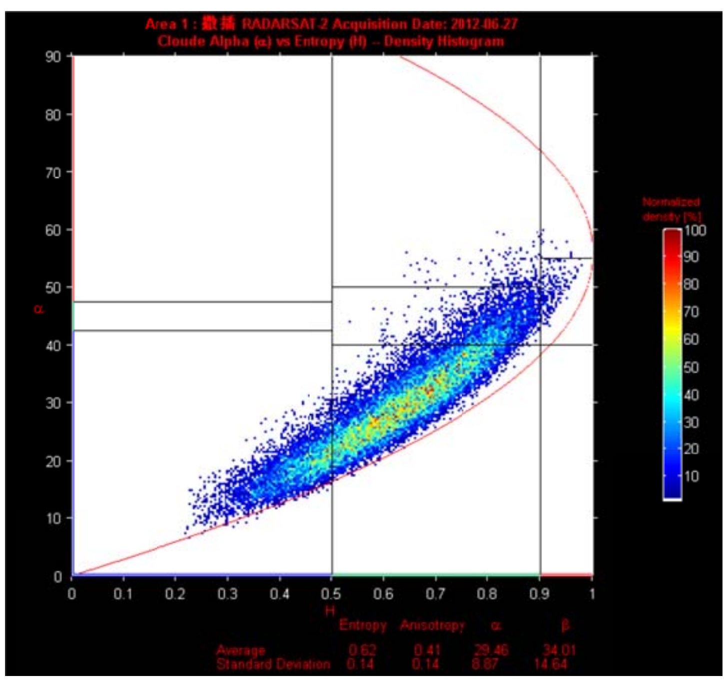


Direct-sowing Rice

Figure 22: H-Alpha Plots



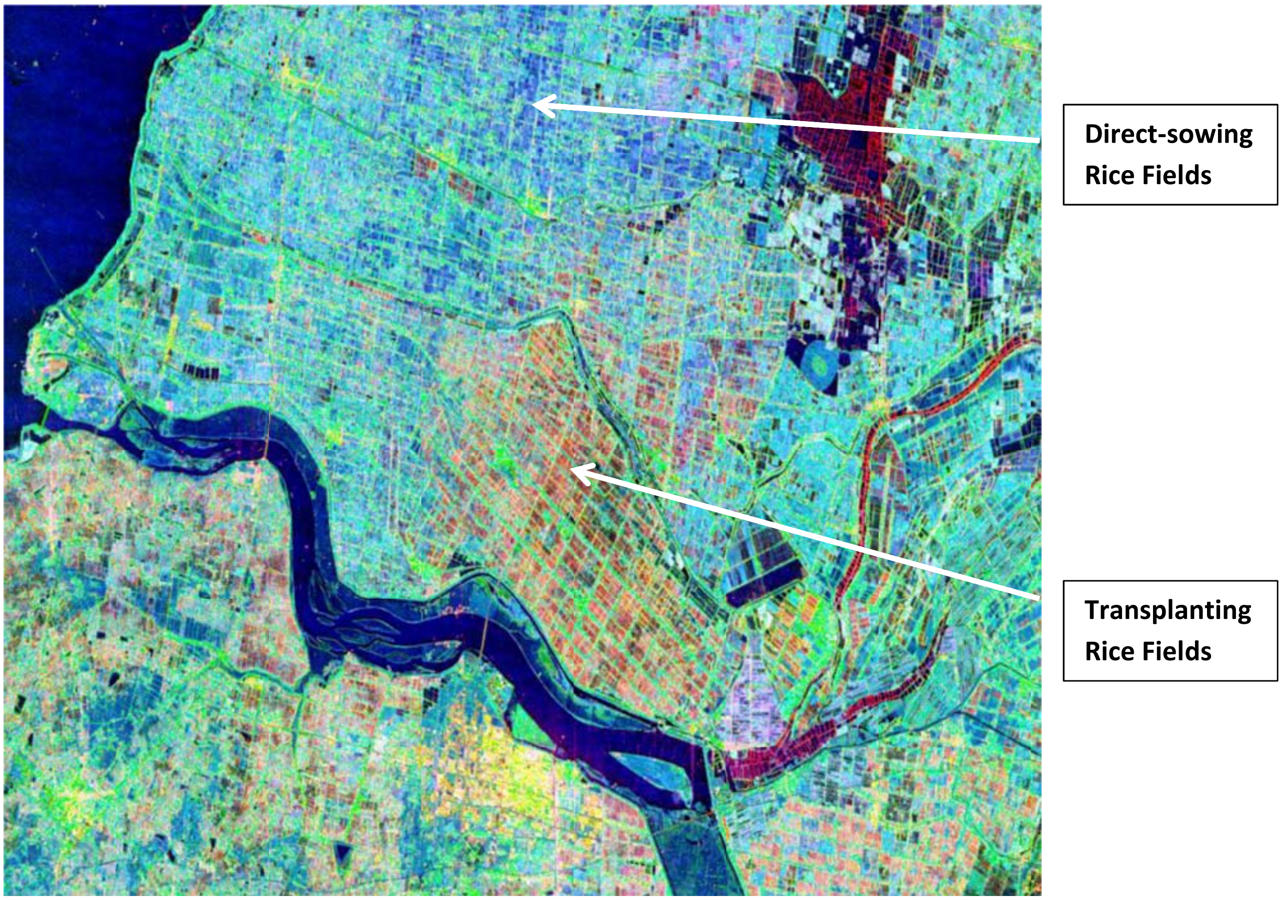
Transplanting Rice



Direct-sowing Rice

Figure 23 gives the result of a Freeman-Durden decomposition based on polametric SAR data acquired on June 27, 2012. Transplanting rice and direct-sowing rice show up very differently in the image of the Freeman-Durden decomposition.

Figure 23: Freeman-Durden Decomposition(R= double bounce, G= volume, B= surface)



Experience with the COVE Planning Tool

The planning spread sheet provided by NASA was not very useful in planning our acquisitions and/or in ordering EO data.

We are interested in taking a short training course (either at the next JECAM meeting or on-line) to be able to run the COVE planning tool ourselves, because we always have problems when we run the COVE.

Plans for Next Growing Season

We will apply for TerraSAR-X polarimetric SAR and high resolution optical data in 2013.

Publications

In 2012, we focused on the twelve synchronized ground campaigns. There are no publications yet.

6.5 Shandong

Team Leader: Wu Bingfang

Team members: Meng Jihua, Zhang Miao, Zeng Hongwei, Zou Wentao, Dong Taifeng, Li Zhongyuan, Liu Guoshui, Chang Sheng, Inkendo J.K., You Xingzhi, Xu Jin, Zheng Yang

Project Objectives

The original objectives of the site have not changed.

- Crop identification and Crop Area Estimation
  - Support vector machine, Decision tree
  - Multi-configuration SAR data
  - Integration of Optical and SAR data
  - Statistical analysis
- Crop Condition/Stress
  - Crop Growing Conditions Over the Growing Season
  - NDVI, NDWI, Vegetation condition index, temperature condition index, crop water stress index, etc.
- Estimation of Biophysical Variables
  - NDVI
  - fAPAR, LAI-Radiation transfer model
  - chlorophyll content-Radiation transfer model/regression analysis
- Yield Prediction and Forecasting
  - Biomass-modified CASA model
    - Water stress factor, temperature stress factor
  - Harvest index
    - Regression analysis of time series NDVI
- Crop Residue, Tillage and Crop Cover Mapping
  - Crop cover and crop residue cover-linear unmixing analysis
  - Tillage-classification
  - Crop residue density-regression analysis
- Phenological Events
  - Logistic regression

Site Description

- Location
  - Top-Left: Latitude: 37.331°N Longitude: 116.319°E
  - Bottom-Right: Latitude: 36.331°N Longitude: 116.819°E
- Topography: Plain
- Soils in the study site are mainly alluvial soil.

- Drainage class/irrigation: Almost all the farmlands are irrigated in the site. Irrigation water comes mainly from a river or underground water.
- Crop calendar: Typical crop rotation is winter wheat and corn. The crop calendar for winter wheat is from mid-October to early June of the next year, and for corn is from mid-June to end of September.
- Field size: Typical field size is 2000 - 8000 m^2.
- Climate and weather: The climatic zone is temperate, semi-arid, monsoon climate. The annual mean temperature is about 13.1℃. The annual mean precipitation is about 582 mm, concentrated from late June to September.

Figure 24: Photographs of Shandong Site

EO Data Received/Used

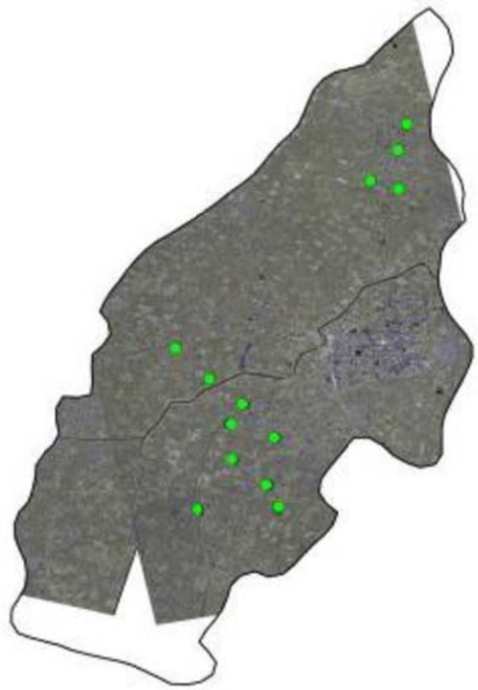
MODIS:

- 46 scenes, from October 10th, 2011 to September 30th, 2012
- H27V05, 250m/500m/1km
- Level 2
- We have no difficulty in acquiring MODIS data, nor in processing and using MODIS data; however, the resolution is too coarse for the study site.

Radarsat-2:

- 4 scenes, September 6th and 7th, 2012, FQ1&FQ12 (Fine Quad Polarization)
- We submitted an order for 16 scenes Radarsat-2 images but we only got 4 scenes. Our other orders were bumped by higher priority orders.
- We used next ESA SAR toolbox (NEST 4B) to process Radarsat-2 data and we have no difficulty in processing it yet.

Figure 25: Sample RADARSAT-2 Image of Shandong Site



TerraSAR-X:

- 3 scenes, May 8th, September 1th and September 6th, 2012, Strip near 004
- Level 1B Product
- We submitted an order for 12 scenes TerraSAR-X images but we only got 3 scenes. Our other orders were bumped by higher priority orders.
- We used next ESA SAR toolbox (NEST 4B) to process TerraSAR-X data but it does not support the data type we acquired. So we have not processed TerraSAR-X data yet.

China Environmental Satellite (HJ-1 CCD, HJ-1 IRS):

- 10 scenes of HJ-1 CCD images, 4 scenes of HJ-1 IRS, From late March to late September, 2012
- CCD: 454-72/455-72/454-73/456-72
- IRS: 454-70/3-70/2-70
- Level 2 Product
- We no difficulty in acquiring HJ-1 data, nor in processing and using HJ-1 data.

<u>In situ Data</u>

The main variables measured and instruments we are using are shown in Table 9.

Table 9: In situ Variables and Instruments - Shandong

Main Variables	Instruments or Processing Method
Spectral reflectance	HR-768 portable spectroradiometer (Spectra Vista Corporation, NK, USA)
FPAR&LAI	SUNSCAN Canopy Analysis system
Dry amount of above ground biomass	Oven dried and weight
Yield	Oven dried and weight
Harvest index	Calculated by yield and AGB
Density/canopy height	Tape measured
Chlorophyll content of leaf	SPAD 502 Plus

All the variables were measured once a month from April to September except for above ground biomass (AGB), yield and harvest index. AGB, yield and harvest index were measured once per cropping season.

The biggest challenge is weather conditions during the field observations. The spectral reflectance should be measured on a sunny, windless day. Weather conditions in the China Shandong site may be not good enough to acquire ground reflectance.

Collaboration

Until now, we have not collaborated with other JECAM sites. But we participate in a collaborative project with staffs from the Yucheng Agro-ecosystem Station, which belongs to the Chinese Ecosystem Research Network (CERN). They helped us to process the crop samples and measured biochemical variables. We can share some of the field measurements data with each other.

Results

FPAR vs. Different Vegetation Indices

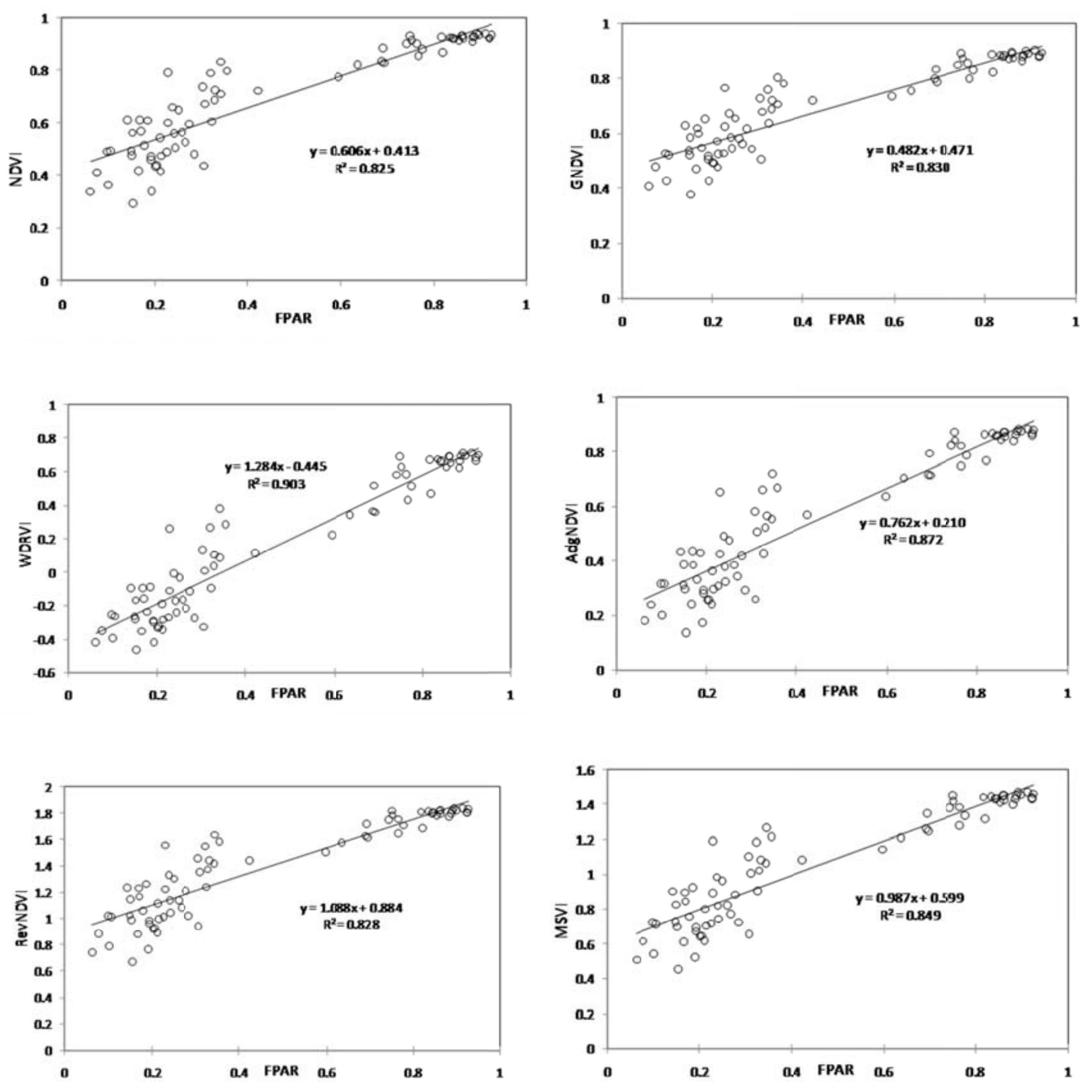
According to the band configuration of HJ -1B CCD data and field measured spectrum, NDVI, GNDVI, WDRVI, RevNDVI, AgbNDVI and MSVI were derived. The formulation of these vegetation indices are shown in Table 10. The relationships between the vegetation indices and FPAR were analyzed and shown in Figure 26. From the regression results, we found that AbgNDVI and MSVI were best correlated with FAPAR since the reflectance of the green band was incorporated into the formulation of these two vegetation indices. The discrimination between green vegetation and soil background can be enlarged.

Table 10: Formulation of Vegetation Indices

Index	Formulation
NDVI	NDVI =(N^a-R^b)/(N+R)
GNDVI	GNDVI = (N-G^d)/(N+G)
WDRVI	WDRVI = (α^eN-R)/(aN+R)
RevNDVI	revNDVI=(G-R)/(G+R)+(N-R)/(N+R)
AgbNDVI	AgbNDVI=(N+G-2R)/ (N+G+2*R)
MSVI	MSVI = (N-($mean^f$(G,R,N)-SD^g(G,R,N)))/(N+(mean(G,R,N)-SD(G,R,N)))

[a] NIR band; [b] RED band; [c] BLUE band; [d] GREEN band; [e] the weight coefficient; [f] the mean of G,R and N; [g] the standard deviation of G,R and N

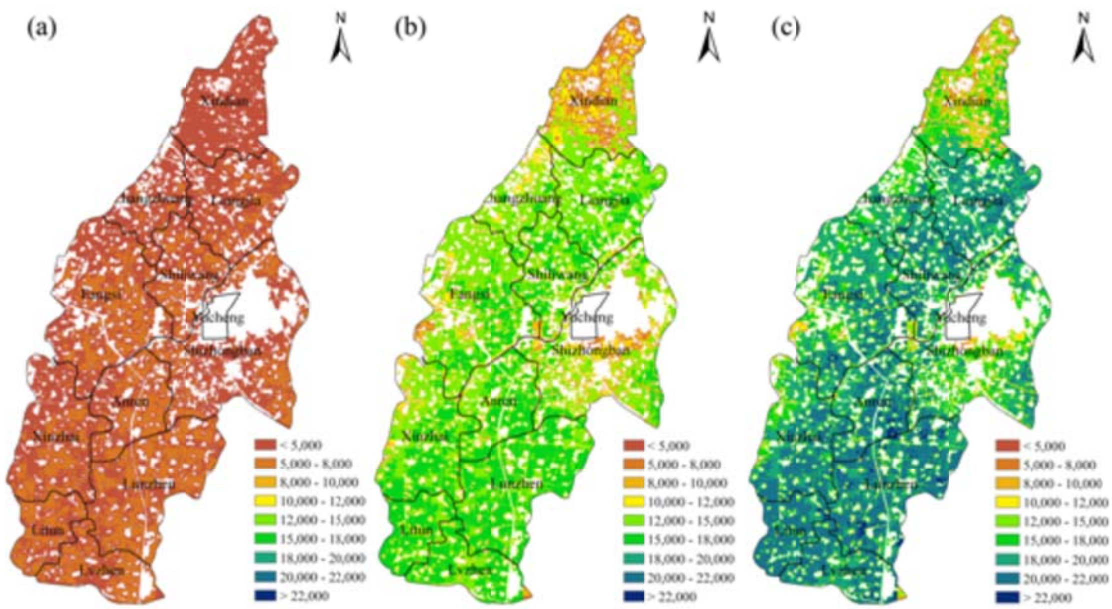
Figure 26: Linear Regression Analysis between Different Vegetation Indices and FAPAR



Winter wheat biomass estimation

The accumulation of aboveground biomass is proportional to accumulated Absorbed Photosynthetic Active Radiation (APAR) based on the Monteith model. The value of LUE is calculated as the product of an optimal LUE (ε*) and its temperature and water stress factors. Based on this concept, the biomass of winter wheat on early April, early May and late May were estimated as shown in Figure 27.

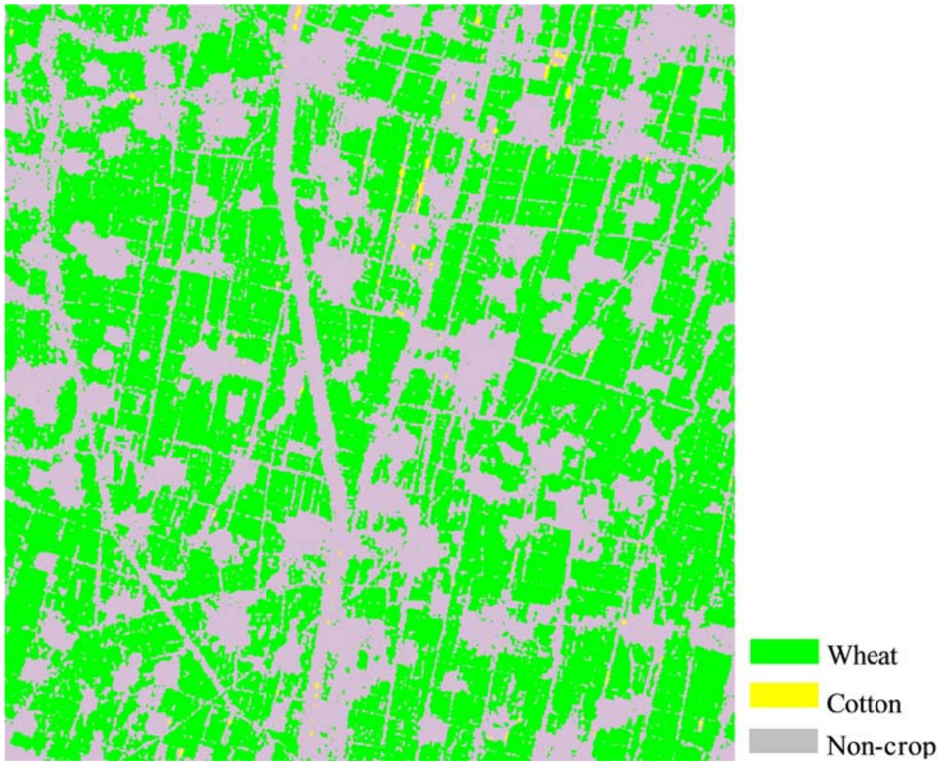
Figure 27: Estimated winter wheat biomass on early April (a), early May (b) and late May (c)



Crop classification

The Support Vector Machine (SVM) classifier was selected for the classification using different combinations of SAR data and texture features. Results indicated that multi-configuration SAR data achieved satisfactory classification accuracy (best overall accuracy 91.83%) in the study area. The best classification result is shown in Figure 28. The classification results using the SVM classifier based on combinations of the three ASAR data, TerraSAR data and Texture features extracted from the SAR data acquired in the flowering period of wheat.

Figure 28: Best Crop Classification Result in Shandong



Experience with the COVE Planning Tool

We did not use COVE Planning Tool to acquire or order EO data. But I think it will be useful in planning the acquisitions. So we are interested in taking a short training course at the next JECAM meeting to be able to run the COVE planning tool by someone who will participate in the next JECAM meeting.

Plans for Next Growing Season

We hope to carry out field experiments synchronous with some satellites through the study site in 2013. In 2013 and the future, we will measure the same variables as in 2012 and we are planning to measure some new variables including air temperature, land surface temperature, soil water content, leaf water content and nitrogen content of crop canopy.

In 2012, we tried to acquire some optical images, such as Rapideye and Worldview-2 images over the same study site but we failed to obtain them because of the weather conditions. We anticipate ordering some high resolution optical data including Rapideye, Worldview-2, UK-DMC2 etc.

We have some difficulty in processing TerraSAR-X data with type of SE_SM_D because the NEST 4B software can only process TerraSAR-X (SSC) products. So we hope we can acquire TerraSAR-X (SSC) products in 2013 and the future.

Publications

Wu Bingfang, Li Qiangzi, Crop planting and type proportion method for crop acreage estimation of complex agricultural landscapes. International Journal of Applied Earth Observation and Geoinformation 16 (2012) 101–112.

Kun Jia, Qiangzi Li, Yichen Tian, Bingfang Wu, Feifei Zhang, Jiahua Meng, 2012. Crop classification using multi-configuration SAR data in the North China Plain. International Journal of Remote Sensing, 33(1): 170-183.

Dong Taifeng, Wu Bingfang, Estimate Faction of Photosynthetically Active Radiation with three-band vegetation indices based on HJ-CDD satellite in wheat: modeling and validation, Agro-Geoinformatics 2012, August 2 - 4, Shanghai, China.

Meng Jihua, Wu Bingfang, Du Xin, Zhang Miao. Estimating regional winter wheat leaf N concentration with MERIS by integrating a field observation based model and histogram matching. Submitted to Transaction of ASABE, third review.

Miao Zhang, Binfang Wu, Qiangzi Li, Jihua Meng, Xin Du, Taifeng Dong, Xingzhi You. Fallowed cropland mapping for better crop monitoring in Huang-Huai-Hai Plain using HJ-1 CCD data. Accepted by the 35th International Symposium on Remote Sensing of Environment (ISRSE35), April 2013, China, Beijing.

Wu Bingfang, Zhang Miao, Hongwei Zeng, New indicators for global crop monitoring in CropWatch. Accepted by the 35th International Symposium on Remote Sensing of Environment (ISRSE35), April 2013, China, Beijing.

7. Italy Apulian Tavoliere

No report received.

8. Mexico

No report received.

9. Paraguay

No report received.

10. Russia

No report received.

11. South Africa

Team Leader: Terry Newby, NEOSS

Team members: Wiltrud Du Randt, ARC; Fannie Ferreira, GTI; Celeste Frost, ARC; Johan Malherbe, ARC; Nicky Knox, SANSA; Rona Beukes, DAFF; Nicolene Thiebaut, ARC; Scott Sinclair, UKZN

Project Objectives

The original project objectives have not changed.

The National Crop Statistics Consortium, comprising the Agricultural Research Council and two private companies – GeoTerraImage (Pty) Ltd and SIQ (Pty) Ltd, supply the Crop Estimates Committee (CEC) of the National Department of Agriculture, Forestry and Fisheries (DAFF) with crop area and yield estimates for the summer and winter grain crops of South Africa. The data currently collected for the Free State JECAM site forms part of this process.

- Crop identification and Crop Area Estimation

The Producer Independent Crop Estimation System (PICES) is based on a statistically sound random selection of sample points from a stratified cultivated land cover dataset. Landsat TM imagery and SPOT 5 Imagery are used to map out cultivated field boundaries for the JECAM site. This dataset is updated periodically (3-5 year intervals). Annually from this field boundary dataset random points are selected and observations on these points are carried out by trained observers from ultra light aircraft platforms. Observations include crop type, condition and other relevant information. (Observations are also made while flying between the selected points. These, plus the selected observed points, are used in image classification as training points for a crop type classification.) The observations of crop type from the statistically sound randomly selected points are used to generate an estimate of the area planted to the various crop types within the study site or province. This forms the basis of the operational system that feeds the Crop Estimates Committee with information.

Dependant on available resources and imagery, a Crop Type map is also generated annually for the Free State JECAM site. This is done using supervised classification where the aerial observations from the PICES system are used as training signatures for the classification.

- Crop Condition/Stress

The Agricultural Research Council maintains a coarse resolution image database (MODIS, SPOT Veg and NOAA AVHRR imagery) operationally which is used with ancillary data such as rainfall and temperature observations from their Automatic Weather Station (AWS) Network to produce a monthly Crop condition and drought monitoring bulletin.

(http://www.arc.agric.za/uploads/images/0_UMLINDI_201212.pdf)

- Soil Moisture

Countywide soil moisture modelling (That includes the JECAM site) is carried out by the University of KwaZulu-Natal Satellite Applications and Hydrology Group (SAHG). The Soil Saturation Index (SSI), which is defined as the percentage saturation of the soil is stored in the TOPKAPI hydrological model and is used and presented monthly within the Umlindi bulletin. The modelling is intended to represent the mean soil moisture state in the root zone.

- Yield Prediction and Forecasting

Yield predictions for the main summer and winter crop (Maize & Wheat) is carried out on a subset of the randomly selected aerial observation points. Points identified as having the crop of interest are selected and a random sample of these points are measured in the field. Plant density, Number of ears/cobs and pip weights are measured. This data is then used to estimate yield in tons per Hectare. This exercise is currently only conducted once in the growing season (May for maize and November for Wheat).

- Crop Residue, Tillage and Crop Cover Mapping

Currently resources are not available to monitor these parameters.

<u>Site Description</u>

See www.JECAM.org for the site description.

<u>EO Data Received/Used</u>

Currently coarse resolution data from the ARC's coarse resolution image database is used for condition and season progression monitoring. The raw data for the database is sourced from the Vegetation Programme of the DevCoCast Programme implemented by VITO and derived products are generated by the ARC. Indicies used for monitoring crop condition include NDVI, VCI and PASG.

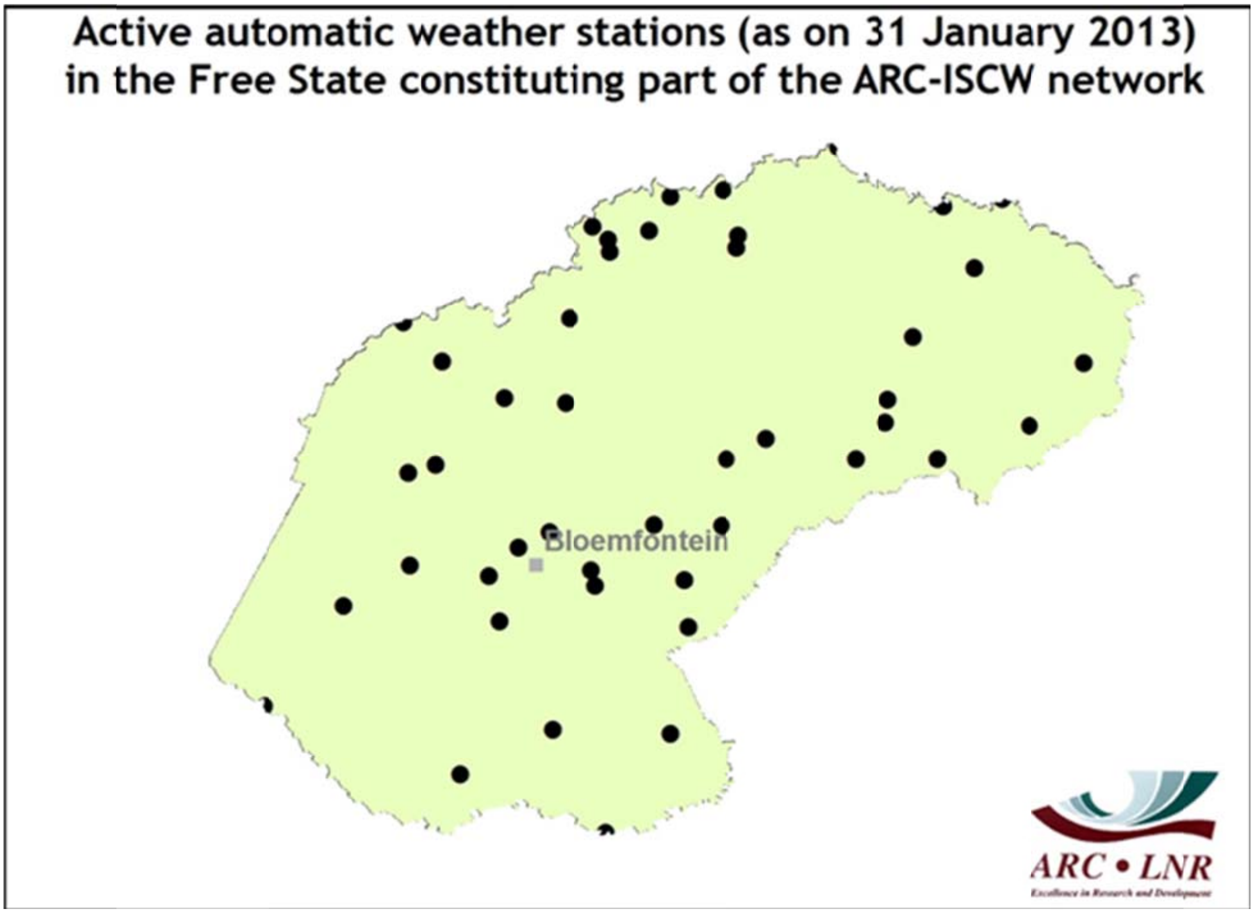
Landsat TM and SPOT 5 imagery (1 or 2 scenes per year per area) are sourced from the South African National Space Agency.

Imagery from other agencies and suppliers as per the JECAM agreements still needs to be sourced.

<u>In situ Data</u>

The JECAM site hosts about 50 automatic weather stations that record a number of climatic parameters on an hourly basis. Figure 29 shows the location of the active weather stations as at 31 January 2013.

Figure 29: Active Automatic Weather Stations (31 January 2013)



Daily data available for these stations are:

- Rainfall
- Temperature (max/min)
- Humidity (max/min)
- Wind speed
- Solar Radiation
- Estimated potential evapotranspiration.

Collaboration

Table 11: Collaborators of South African JECAM Site

Collaboration Partner Contact Person	Subject	Status
Dr. Fernando Camacho de Coca Managing director: Earth Observation Laboratory (EOLAB) http://www.eolab.es Pr. Pierre Defourny Earth and Life Institute - Environmental Sciences Université catholique de Louvain Belgium	Free State JECAM site offered as study site for IMAGINES project	Networking on going
Xin DU, Ph.D. Lab for Agriculture and Environment Institute of Remote Sensing Applications(IRSA) Chinese Academy of Sciences(CAS) Beijing, P. R. China E-mail: duxin@irsa.ac.cn	Request to collaborate on research projects	Contact made – requires follow up.
Dr Benjamin Koetz, European Space Agency, ESA-ESRIN Exploitation & Services Division, Project Section email: Benjamin.Koetz@esa.int	Collaboration requested to use JECAM site in ESA Agricultural project	Networking on going

Results

Based on the methodologies described above and after discussion and verification by the Crop Estimates Committee, the Preliminary estimated area planted to summer crops (24 Jan 2013) is reflected in Table 12 (source: DAFF). Table 13 reflects the final estimates for the 2012 year (source: DAFF).

Table 12: Preliminary Estimated Area planted (Ha) (2013) – Free State

Free State JECAM Site	Preliminary Estimated Area planted (Ha) (2013)
White maize	725 000
Yellow maize	505 000
Total maize	1 230 000
Sunflower seed	210 000
Soya-beans	215 000
Groundnuts	17 300
Sorghum	33 000
Dry beans	16 000

Table 13: Actual Estimated Areas planted (2012) – Free State

Free State JECAM Site	Actual Estimated Areas planted (2012)
White Maize	710 000
Yellow Maize	450 000
Sunflower Seed	190 000
Soya-Beans	175 000
Groundnuts	20 000
Dry Beans	16 000
Sorghum	22 000

Experience with the COVE Planning Tool

Currently the team is exploring the tools and systems for accessing the JECAM image offerings.

Plans for Next Growing Season

Dependent on resource availability, field data collection will be expanded as much as resources allow. Consideration will be given to also include data collection relating to rangeland production. We anticipate ordering the same type/quantity of EO data next year.

Publications

Durand, W., du Toit, D.L. and G. Patterson (2012) **Crop yields based on earth observation models in the Free State Province**. (ARC Internal report to DAFF).

Durand, W. & du Toit, D.L. **Report on Objective Yield for the April-May 2012 Maize Survey** (ARC Internal report to DAFF)

Frost, C. Thiebaut N. Newby T.S. (in prep), **Exploring Terra MODIS Satellite Sensor Data Products for Crop Maize Yield Estimation in South Africa**.

12. Ukraine

Team leader: Prof. Nataliia Kussul

Team Members: Prof. Andrii Shelestov, Dr. Sergii Skakun, Dr. Oleksii Kravchenko

Project Objectives

The original objectives have not changed.

- Crop identification and Crop Area Estimation
- Yield Prediction and Forecasting.

Site Description

- Location

The site consists of two parts:

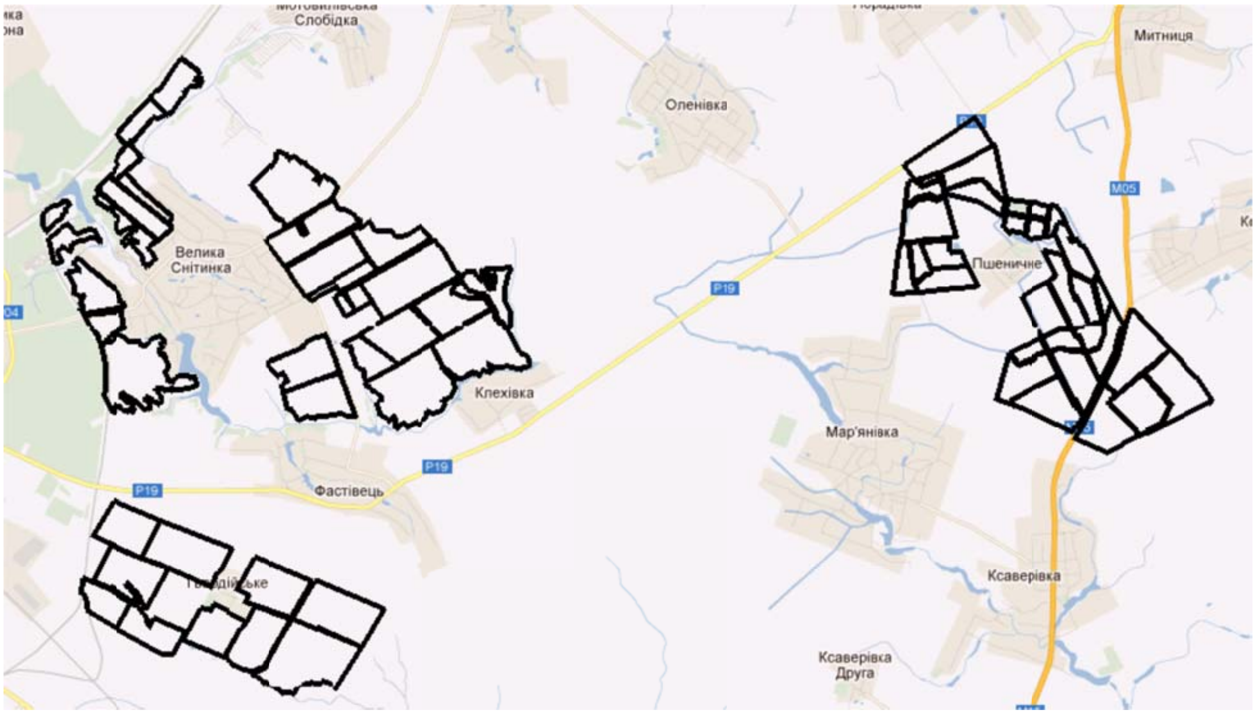
- the whole Kyiv region (28,000 sq. km) indented for crop mapping and acreage estimation;
- intensive observation sub-site (25x15 sq. km.) indented for crop biophysical parameters estimation. This sub-site consists of two research farms of National University of Life and Environmental Sciences of Ukraine where intensive in-situ measurements are being collected.

The latitude and longitude of the site and sub-site are given in Table 14. The map of the intensive observation sub-site is shown in Figure 30. The research fields are outlined in black.

Table 14: Geographical Coordinates of the Ukraine Test Sites

Kyiv		
Centroid		Latitude: 50.355 Longitude: 30.715
Site Extent	**Top left**	Latitude: 51.54 Longitude: 29.26
	Bottom right	Latitude: 49.17 Longitude: 32.17
Sub-site for Intensive Observation (Pshenichne and Velyka Snitynka research farms of NULESU).		
Centroid		Latitude: 50.075 Longitude: 30.11
Site Extent	**Top left**	Latitude: 50.14 Longitude: 29.96
	Bottom right	Latitude: 50.01 Longitude: 30.26

Figure 30: Map of intensive observation sub-site (Pshenichne and Velyka Snitynka research farms of NULESU)



For winter wheat yield forecasting, the whole territory of Ukraine was considered. Forecasting was done at oblast level. Oblast is a sub-national administrative unit that corresponds to the NUTS2 level of the Nomenclature of Territorial Units for Statistics (NUTS) of the European Union.

- Topography: The landscape is mostly flat with slopes ranging from 0% to 2%. Near 10% of the territory is hilly with slopes about 2-5%.
- Soils: The soils of the cultivated land are mainly different kinds of chenozems.
- Drainage class/irrigation: Soil drainage ranges from poor to well-drained. Irrigation infrastructure is limited. About 6% of the territory is drained (1700 km^2). About 4% (1200 km^2) of the territory is used for irrigated agriculture.
- Crop calendar: The crop calendar is September-July for winter crops, and April-October for spring and summer crops.
- Field size: Typical field size is 30-100 ha.
- Climate and weather: The climatic zone is humid continental.
- Agricultural methods used: Crop types include winter wheat, spring barley, maize, soy beans, winter rapeseed, sunflower, sugar beet, potatoes, winter rye, and spring wheat. Due to relatively large number of major crops and other factors there is no a typical simple crop rotation in this region. Most producers use different crop rotations depending on specialization.

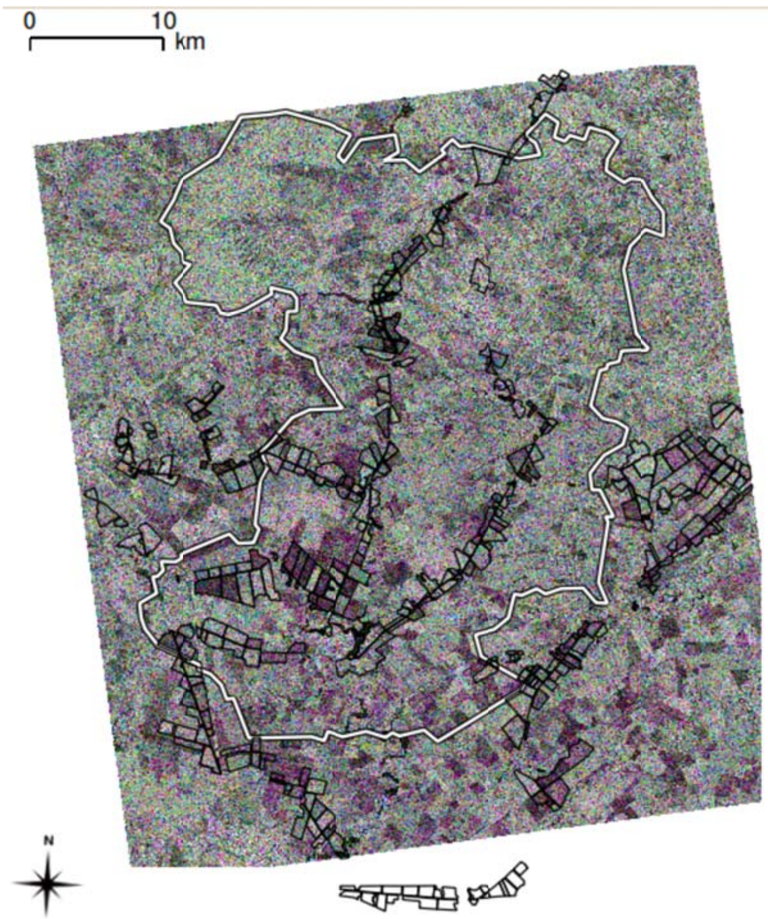
<u>EO Data Received/Used</u>

RADARSAT-2

- Number of scenes: 4 on 27 and 30 July 2012
- Beam modes/ incidence angles/ spatial resolutions:
  - 27 July 2012: FQ8, 26.12-29.40, 5 m
  - 30 July 2012: FQ21, 38.59-42.16, 5 m
- Processing level: SLC
- No challenges in ordering, acquiring, processing and using the data.

See Figure 31. The test site area is shown in white.

Figure 31: Boundaries of Observed Crop Fields outlined in Black over RADARSAT 2 Quad-pol Image



EO-1

- Number of scenes: 1 on 28 July 2012
- Look angle: -26.71, spatial resolution: 30 m
- Processing level:
- No challenges in ordering, acquiring, processing and using the data.

Winter wheat yield forecasting

NDVI values for Ukraine were extracted using the MOD13Q1 product generated from the MODIS instrument on board the Terra satellite. MOD13Q1 data are provided every 16 days at the 250 m resolution in the sinusoidal projection. NDVI images are composited over a 16-days interval to create a cloud-free map with minimal atmospheric and sun-surface-sensor angular effects. Data for the territory of Ukraine and 2000-2011 time interval were downloaded from the Land Processes Distributed Active Archive Center (LP DAAC) of the USGS.

In order to derive a map of crop lands for the territory of Ukraine, the ESA GlobCover land cover map was used. This map was produced at the 300 m spatial resolution using as input observations from MERIS sensor on board the ENVISAT satellite mission. In particular, we used the GlobCover map version 2.3 that covers the period of January-December 2009. Only areas identified in the GlobCover land cover map as a Rainfed croplands class (class value 14) were used for averaging NDVI values derived from the MOD13Q1 product. For this purpose, NDVI maps and GlobCover map were transformed to the Albers Equal Area projection.

In situ Data

Ground observations to support satellite images were carried out on 4 August 2012 to collect in situ measurements (Table 16). In total, information was collected on 271 fields. The following crop types were present (Table 15): maize, soy beans, sunflower, sugar beet, harvested winter and spring crops, and minor crops like buckwheat.

Table 15: Ground survey statistics in 2012

Crop	***Fields observed, %***	***Total area (ha), %***
Maize	63 (23.2%)	6264 (29.5 %)
Soy beans	46 (17.0%)	3553 (16.7 %)
Sunflower	19 (7.0%)	1722 (8.1 %)
Sugar beet	12 (4.4%)	1130 (5.3 %)
Winter and spring crops (already harvested)	79 (29.2 %)	6184 (29.1 %)
Non agricultural land and minor crops	52 (19.2 %)	2369 (11.2 %)
Total	271 (100 %)	21222 (100 %)

Table 16: Total Accuracy, Commission and Omission Classification Errors

Crop	***EO1 + R2***		***EO1***		***R2***	
Total acc.	***91.4 %***		***84.8 %***		***88.9 %***	
	Comm., %	Om., %	Comm., %	Om., %	Comm., %	Om. ,%
Maize	11.8 %	4.8 %	17.6 %	11.1 %	13.6 %	9.5 %
Soy beans	6.1 %	18.4 %	7.4 %	**34.2 %**	10.8 %	**13.2 %**
Sunflower +s.beet	20.0 %	23.1 %	39.3 %	34.6 %	28.0 %	30.8 %
Winter + spring	2.8 %	1.4 %	6.7 %	1.4%	2.9 %	4.2 %

Collaboration

We have been approached to participate in a collaborative project with the Project "Validation of GAI and FAPAR products derived from coarse spatial resolution remote sensing data over JECAM cropland sites". Discussions are in progress.

Results

Crop mapping

Collected data was used for preliminary analysis of the discriminating power of optical, SAR and a combination of them both by visual interpretation and supervised classification. In contrast to optical images, visual interpretation of SAR images allows distinguishing maize, soy beans and combined sunflower & sugar beet crops due to different canopy architecture and different scattering processes. Sugar beet and sunflower could not be discriminated.

Numerical analysis was performed using a Support Vector Machine (SVM) classifier. Classification accuracies, commission and omission errors were estimated using a five-fold cross-validation procedure. Special care has been taken to prevent over-fitting of cross-validation procedure due to spatial correlation in collected data. Three different data sets were examined: combined EO-1 and RADARSAT-2, EO-1 only and RADARSAT-2 only data (Table 16). Total accuracies appear similar in all datasets because they are heavily influenced by the winter + spring crop class that is classified equally well by optical and SAR data.

Figure 32: Crops in Ukraine


Maize Sugar Beets


Sunflowers Soy Beans

The difference between datasets lies in per crop classification errors. All summer crops are better classified using SAR data than optical data. The most profound effect is observed on soy beans which is the second major summer crop after maize in the area. Using SAR data instead of optical allows the omission error for soybeans to decrease from 34% to 13% while maintaining a similar level of commission error.

The combined dataset shows gradual decrease of errors for most crops 5% to 10%. Sunflower + sugar beet class is the most beneficial as combined data allows decreasing classification errors in 1.5-2 times in comparison with optical or SAR data alone. This result is explained by the complementary roles of SAR and optical data for discriminating sunflower at flowering phenological stages.

Winter wheat yield forecasting

An empirical regression model was built for each oblast that connected 16-day NDVI composites derived from the MODIS sensor at 250 m resolution and official statistics on winter wheat yield. Using a leaveone-out cross-validation procedure, the best time for making reliable yield forecasts in terms of root mean square error was identified. For most oblasts, NDVI values taken in April-May provided the minimum RMSE value, thus enabling forecasts 2-3 months prior to harvest. Performance of the models in terms of relative efficiency (which shows how much the RMSE error can be reduced using satellite data comparing to the trend model) and the coefficient of determination was dependant on the agro-climatic zone being on average 1.2 and 0.4 for Plane-Polissya, 1.5 and 0.7 for Forest-Steppe, and 1.9 and 0.8 for Steppe, respectively. When adding new observations, the models were robust in the sense that relative efficiency and coefficient of determination remained relatively unchanged.

This approach was compared to other two approaches: empirical model based on meteorological observations and WOFOST crop growth simulation model implemented in the CGMS system. All three approaches were run to produce winter wheat yield forecasts for independent data sets for 2010 and 2011, i.e. on data that were not used within model calibration process. The most accurate predictions for 2010 were achieved using the CGMS system with RMSE value of 0.3 t ha-1 in June and 0.4 t ha-1 in April, while performance of three approaches for 2011 was almost the same (0.6 t ha-1 in April). It is important to note that both the NDVI-based approach and the CGMS system overestimated the winter wheat yield comparing to official statistics in 2010, and underestimated it in 2011. Nevertheless, since the official statistics are biased, we cannot conclude that these models over- or underestimated real values of winter wheat yield. This question remains open as it requires more detailed analysis and availability of statistical data.

Therefore, we can conclude that performance of the empirical NDVI-based regression model was similar to the meteorological and CGMS models when producing winter wheat yield forecasts at oblast level in Ukraine 2-3 months prior to harvest, while providing minimum requirements to input datasets.

To what extent have the project objectives been met?

Crop mapping with SAR images is an ongoing project that will continue in 2013. Winter wheat forecasting using MODIS images were already put into operation.

Can this approach be called 'best practice'?

We think that both approaches on crop mapping and winter wheat forecasting could be considered as best practice.

<u>Experience with the COVE Planning Tool</u>

In general, the planning spread sheet provided by NASA was useful in planning our acquisitions and/or in ordering EO data.

We are interested in taking a short training course (either at the next JECAM meeting or on-line, estimated duration 30 – 60 minutes) to be able to run the COVE planning tool ourselves.

Plans for Next Growing Season

More research in 2013 will be done on the assessment of SAR capabilities for crop mapping in Ukraine. We anticipate ordering the same type/quantity of EO data next year.

Publications

Articles

- N. Kussul, S. Skakun, A. Shelestov, O. Kravchenko, J.F. Gallego, and O. Kussul, "Crop area estimation in Ukraine using satellite data within the MARS project," in: IEEE International Geoscience and Remote Sensing Symposium IGARSS 2012, 22-27 July 2012, Munich, Germany, pp. 3756-3759.
- J. Gallego, A. Kravchenko, N. Kussul, S. Skakun, A. Shelestov, and Y. Grypych, "Efficiency Assessment of Different Approaches to Crop Classification Based on Satellite and Ground Observations," J. of Automation and Inf. Sci., vol. 44, no. 5, pp. 67–80, 2012.
- N. Kussul, A. Shelestov, S. Skakun, O. Kravchenko, B. Moloshnii, "Crop state and area estimation in Ukraine based on remote and in-situ observations," Int. J. on Information Models and Analyses, vol. 1, no. 3, pp. 251-259, 2012.
- F. Kogan, N. Kussul, T. Adamenko, S. Skakun, O. Kravchenko, O. Kryvobok, A. Shelestov, A. Kolotii, O. Kussul, A. Lavrenyuk, "Winter wheat yield forecasting in Ukraine based on Earth observation, meteorological data and biophysical models," Int. J. of Appl. Earth Observ. Geoinf., 2013. (accepted)
- N. Kussul, S. Skakun, O. Kravchenko, A. Shelestov, J.F. Gallego, O. Kussul, "Crop Area Estimation with Satellite Images in Ukraine," IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens., 2013 (submitted)

Presentations

- "Crop area estimation in Ukraine using satellite data within the MARS project" (N. Kussul, S. Skakun, A. Shelestov, O. Kravchenko, J.F. Gallego, and O. Kussul), IEEE International Geoscience and Remote Sensing Symposium IGARSS 2012, 22-27 July 2012, Munich, Germany.
- "Forecasting winter wheat yield in Ukraine using 3 different approaches" (N. Kussul, S. Skakun), EC-JRC Geoland2 CROP CIS technical meeting, 14-15 May, 2012, Ispra, Italy.
- "Regression Models for Winter Wheat Yield Forecasting using Satellite Data" (N. Kussul, A. Shelestov, S. Skakun, O. Kravchenko, A. Kolotii), 3rd Ukrainian Conference "Earth Observations for Sustainable Development and Security" (GEO-UA 2012), September 3-7, 2012, Yevpatoriya, Crimea, Ukraine.
- "Crop state and area estimation in Ukraine based on remote and in-situ observations" (N. Kussul, A. Shelestov, S. Skakun, O. Kravchenko, B. Moloshnii), Joint International Scientific Events on INFORMATICS (ITA 2012), June 18 - July 05, 2012, Varna, Bulgaria.

13. U.S.A.

Team Leader and Members: Michael Cosh, USDA-ARS-HRSL, Joe Alfieri, USDA-ARS-HRSL, Martha Anderson, USDA-ARS-HRSL, Craig Daughtry, USDA-ARS-HRSL, Bill Kustas, USDA-ARS-HRSL, John Prueger, USDA-ARS-NLAE, Ali Sadeghi, USDA-ARS-HRSL, Mark Tomer, USDA-ARS-NLAE

Project Objectives

The original project objectives for our site have not changed.

- Crop identification and Crop Area Estimation
  - Crop area estimation was conducted via the USDA Farm Service Agency and National Agricultural Statistical Service programs for the South Fork. This is an operational product.
- Crop Condition/Stress
  - As part of a remote sensing project, the evaporative stress index (ESI) is being computed on a 10 km resolution for the continental U.S. This is available from http://hrsl.arsusda.gov/drought/. This is operational.
- Soil Moisture
  - Four soil moisture stations were in place for the past year, but plans have been developed to expand this network to approximately twenty stations for the upcoming soil moisture calibration/validation program of the NASA SMAP mission. This is still in development.
- Crop Residue, Tillage and Crop Cover Mapping
  - Assessments of crop residue amount are in the process of being analyzed for publication on methodologies for estimation. This is still in development.

Site Description

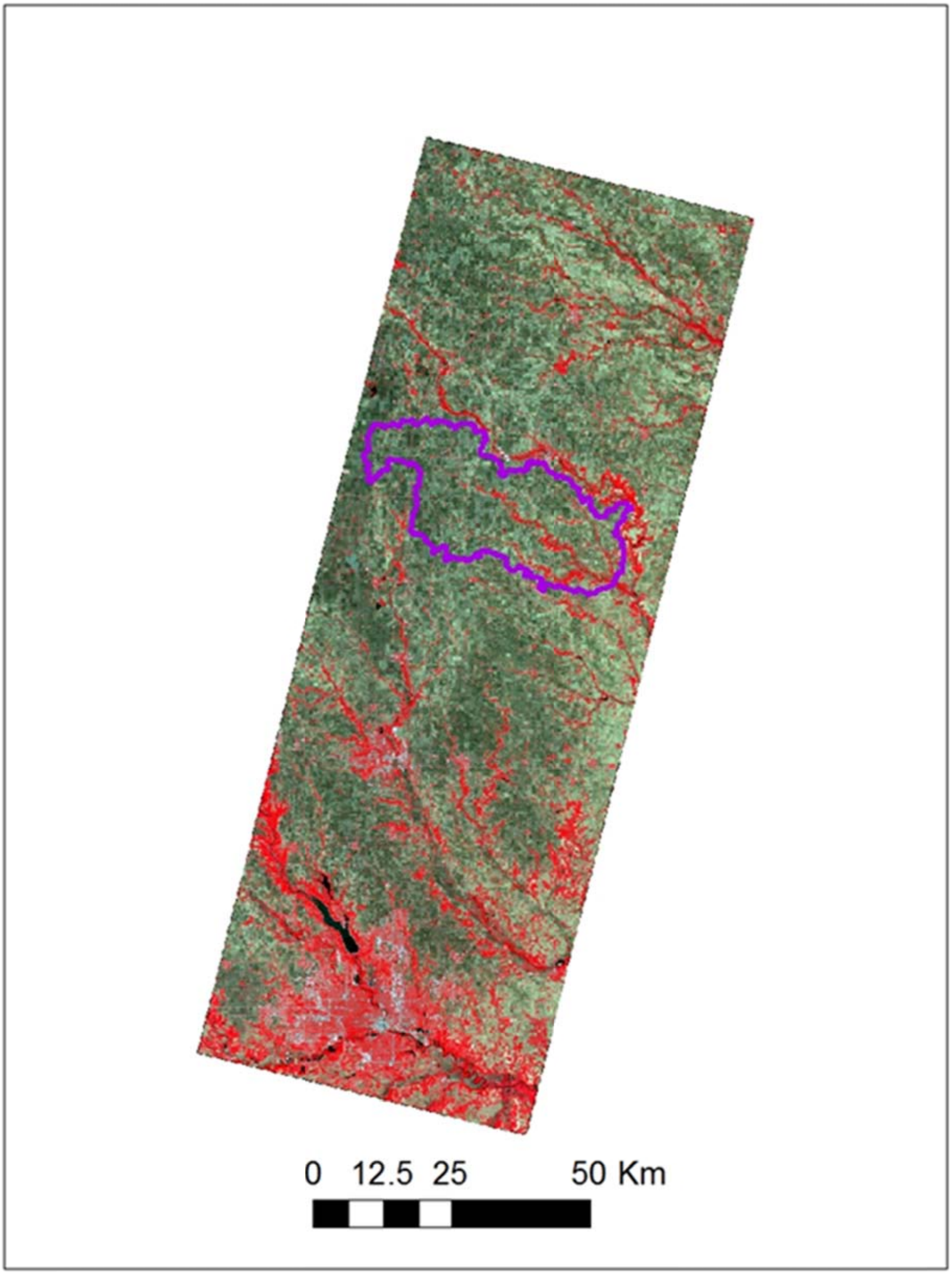
- Location: South Fork, Iowa (Hardin and Hamilton Counties, Iowa, USA)
- Topography: Flat
- Soils: Clay Loam
- Drainage class/irrigation: Poorly Drained, Installed Drainage Tiles, limited irrigation.
- Crop calendar: April/May Planting, September/October Harvest
- Field size : 800 m by 800 m
- Climate and weather: Temperate/Humid
- Agricultural methods used: Corn and Soybean, no-till and tilled.

EO Data Received/Used

SPOT

Our principle use of satellite data involves SPOT, which is available through a USGS contract with SPOT Image. Two scenes were used for the study on crop residue from Spring of 2012. These scenes were requested via the USGS contract specifically. Figure 33 is an example of the SPOT image used for this study.

Figure 33: SPOT Image from 5/16/12 with the South Fork Watershed Outline in Purple



Hyperion

HRSL scientists have attempted to schedule Hyperion overpasses for the past several years, but have not been able to obtain access.

In situ Data

There are currently 4 in situ soil moisture stations collecting soil moisture, soil temperature and precipitation data in the South Fork Region. In addition, during the Spring and Fall, in situ crop residue studies were conducted to estimate residue amounts via field measures and roadside surveys.

Collaboration

Dr. Xin Du approached our laboratory about yield forecasting studies. He was forwarded to the appropriate scientists doing work in that domain.

Results

The majority of the work in this domain is research in progress with no substantial conclusions yet. Data collection and infrastructure improvement are the primary tasks.

Experience with the COVE Planning Tool

We have not been able to exploit the COVE Planning Tool at this time. An online training course would be of interest to us.

Plans for Next Growing Season

We will continue to measure crop residue and will be expanding the soil moisture network this spring to almost 20 stations. This will be in coordination with NASA for a precipitation study. Two atmospheric flux towers, which were removed at the end of 2011, will be redeployed in 2013 we hope.

Publications

No papers have been published yet on this site.

14. JECAM Support to Important Multi and Bi lateral Work

There is already significant bi-lateral collaboration between JECAM sites planned and underway. In addition, the site network is being used to support research external to JECAM. Examples include:

- ESA Sentinel-2 Simulation over JECAM sites
- IMAGINES project
- NASA-Canada SMAP Validation Experiment (SMAPVEX)
- UMD-Validation of LAI and FAPAR derived from coarse spatial resolution data
- EC FP7 Proposals.

SMAPVEX

SMAP will provide global soil moisture data using active radar and passive microwave sensors. AAFC was asked by NASA and U.S. Department of Agriculture to lead an international SMAP validation experiment using the Red River JECAM site. SMAPVEX will help NASA to validate their models for soil moisture retrieval and will be used to adapt AAFC models to use SMAP data. This work involved 75 scientists. In Canada, AAFC, Environment Canada, the Manitoba provincial agriculture ministry (MAFRI) and 3 universities participated. The U.S. team includes NASA, Jet Propulsion Lab, USDA and 10 universities. The campaign lasted 6 weeks and resulted in 45,000 soil moisture measurements; NASA flew 2 aircraft 17 times.

ESA Sentinel-2 Simulation over JECAM sites

Six JECAM sites were asked to participate. Five are able to support the mission with ground data. ESA will acquire Spot-4 and RapidEye over the sites from February through May. The SPOT-4 orbit was lowered 3km to mimic the Sentinel-2 Constellation 5 day repeat cycle. Simulated multi-temporal datasets will be made available in June.

European Commission FP7 and JECAM

Evaluations of proposals are underway now. Linkages to and expansion of JECAM sites have been identified by the proposals. It is anticipated that the JECAM site network will make a significant contribution to GEOGLAM through the FP7 project, once proposals have been selected and implemented.

15. New JECAM Site Proposals

Several potential new sites have come forward recently.

Tunisia (CISBO) has documented their site already. They have cereals / forage / broad beans in winter, and vegetables in summer.

The following documented tropical sites link in with the CIRAD mission:

- Madagascar (Antsirabé) : mid-altitude mixed rice cropping system; irrigated on terraces or basins, and rainfed on the hills. This is a partnership with FOFIFA.
- Tanzania (Rungwe) : highland agro-forestry system based on coffee, banana and corn. This is a partnership with the State University of Sao Paulo (UNESP).
- Brazil (Sao Paulo) : mainly eucalyptus tree plantations (typical field size of 50 ha), and sugar cane, pastures, citrus orchards. This is a partnership with ICRAF.