

GDA Corp.

**Operational Information
Extraction from P6-
A WiFS Imagery**

“ResourceSat Real Product Innovations”

Seminar

November 27, 2007



GDA Corp.

Content

1. Surface Reflectance Calibration

2. Feature Detection

**3. Crop Mapping and Crop Area
Statistics Collection**

4. Flood Mapping



P6-A WiFS Image Processing: Surface Reflectance (assumes Standard Atmosphere)



AWiFS Surface Reflectance

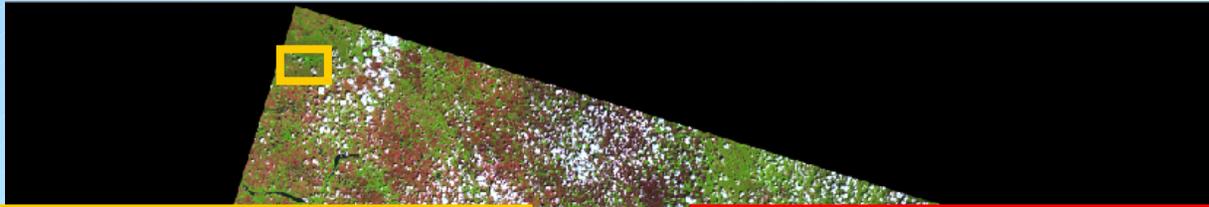
Main goals:

To correct AWiFS imagery for per pixel variations in view and solar geometry, incidence angle, Earth curvature, surface elevation, & view and solar paths through the atmosphere and atmospheric transmittance along the paths.

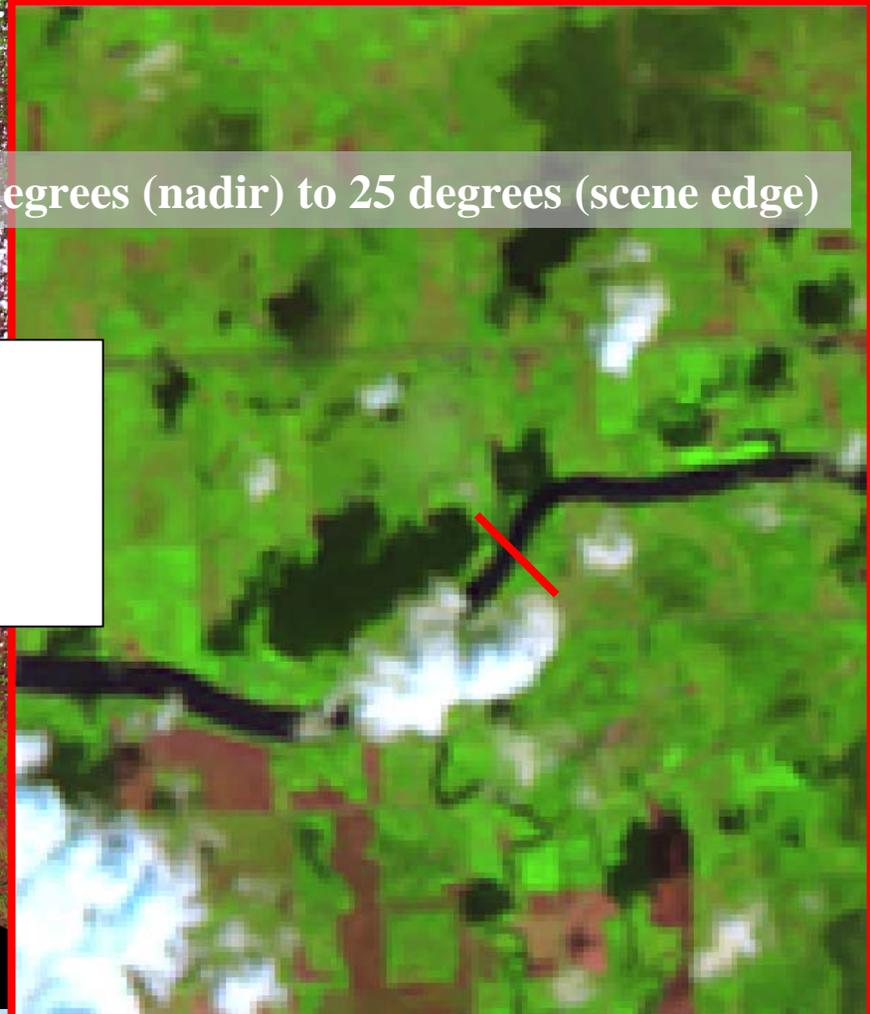
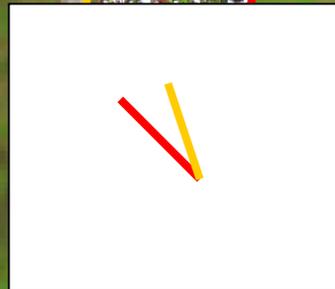
To deliver surface reflectance corrected imagery to clients in an operational setting (*i.e.*, within hours after image acquisition).



AWiFS Geometry

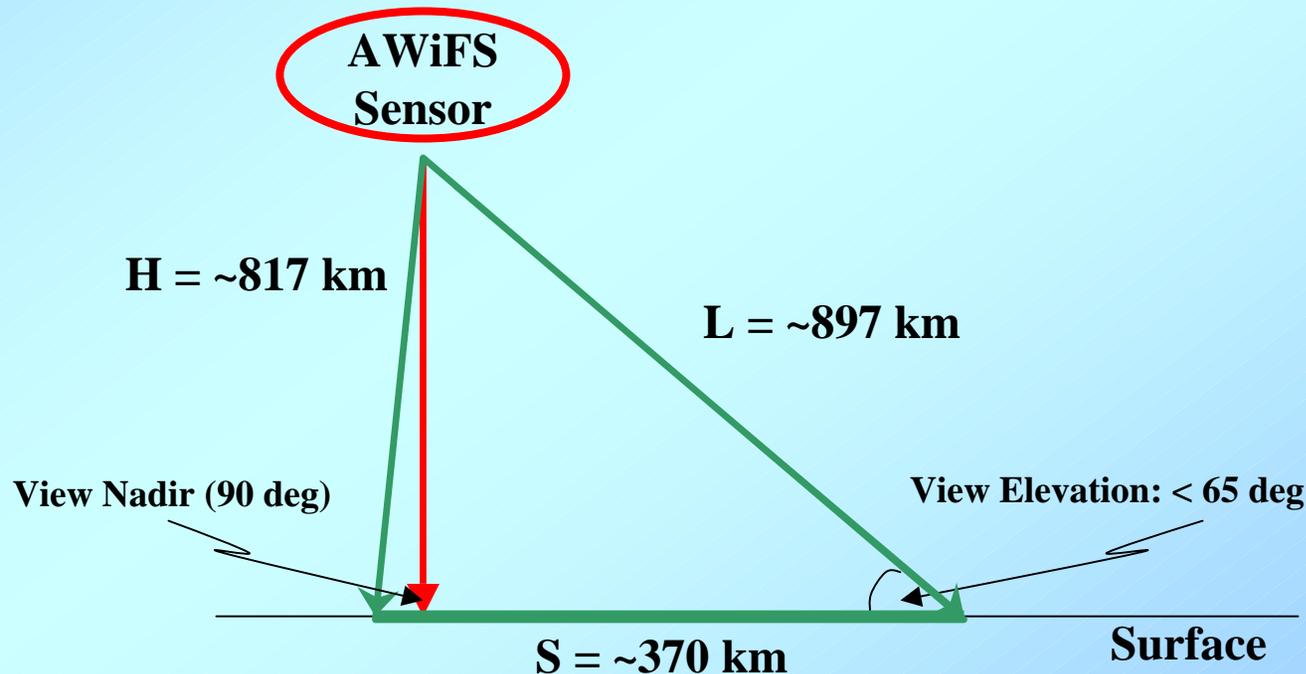


View Zenith changes across the scene: from 0 degrees (nadir) to 25 degrees (scene edge)



AWiFS Surface Reflectance

- AWiFS has significant variation of view elevation across the scene, and hence
- Distance from the sensor to the ground is ~10% longer on the edge of the scene if compared to the sensor-ground distance for nadir location,



AWiFS Surface Reflectance

- There are, therefore, per pixel differences in atmospheric transmittance along the view path,
- These differences lead to ~10% degradation in pixel values near the edge of the scene.

An Example of pixel value change across the scene for DN=255
(Sun Elevation = 90 deg, DEM = 0 km, View Azimuth = 0 deg, Sun Azimuth = 0 deg)

View Elevation	Band 2 (Blue)	Band 3 (Red)	Band 4 (NIR)	Band 5 (SWIR)
90 degrees (nadir)	255	255	255	255
65 degrees	233	232	232	231



AWiFS Surface Reflectance

GDA Surface Reflectance Calibration:

- Corrects for variations in view and solar geometry, incidence angle, Earth curvature, surface elevation, & atmospheric transmittance across the scene.
- Calculates surface reflectance values, assuming (i) standard atmosphere and (ii) no surface LC anisotropy, *i.e.*, no BDRF effects.
- A general equation is below

$$\rho = (\pi \cdot (L_{\lambda} - L_p) \cdot d^2) / (\cos(\Theta) \cdot E_0 \cdot T_z + E_d) \cdot T_v$$

ρ is surface reflectance,

L_{λ} is at-sensor spectral radiance,

L_p is path radiance,

d is earth-sun distance in astronomical units, varies according to the Julian day,

Θ is sun elevation,

E_0 is mean per band solar spectral irradiance value,

E_d is diffuse sky irradiance,

T_z is atmospheric transmittance along the solar path,

T_v is atmospheric transmittance along the view path.



Crop Mapping and Crop Area Statistics Collection with P6- AWiFS Imagery



Crop Mapping

Goals:

To be able to rapidly, and with an acceptable level of accuracy, map dominant and 1-3 subdominant crops for main agricultural regions of the world and

For each administrative unit (or some other AOI), to provide customers with:

- (i) crop maps,**
- (ii) crop area statistics, and**
- (iii) maps and statistics of crop area changes between image acquisitions**



Crop Mapping

Approach:

Employs combination of

- * unsupervised, guided classification to generate training data and per crop multivariate conditional probabilities and
- * automated supervised classification--Bayesian probabilistic, weight of evidence--to map crops and depict classification confidence

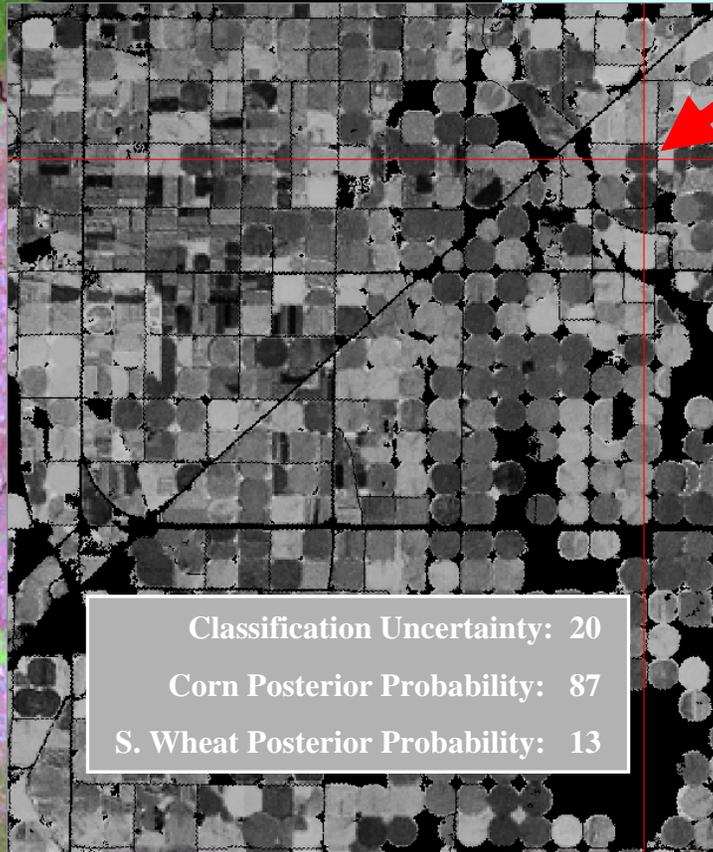
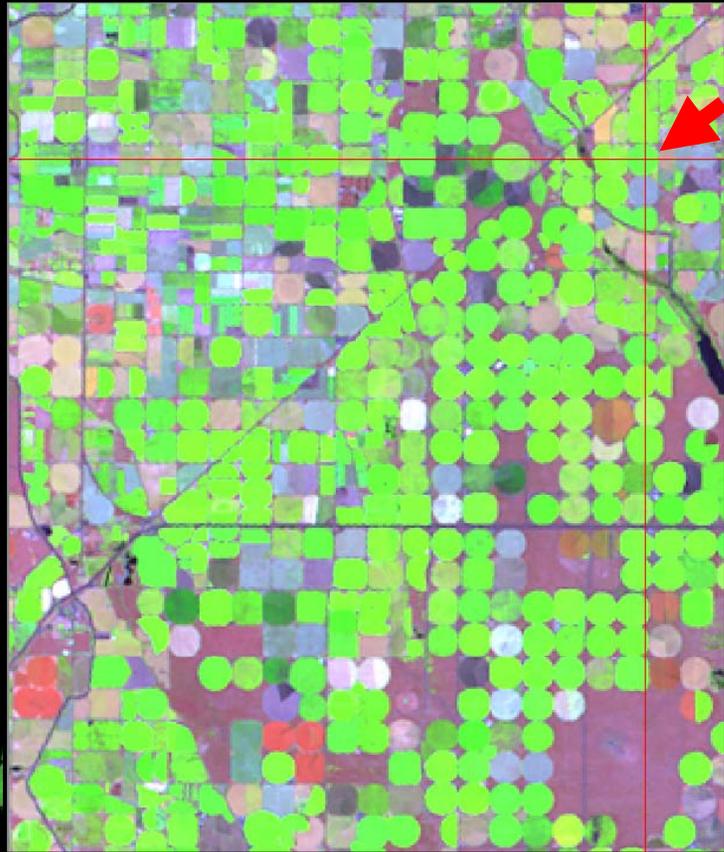
Relies on multiple lines of evidence:

- * results of near-real time cropland monitoring with moderate resolution imagery,
- * forecasts of crop type and crop area from historical crop statistics
- * expected crop phenology and, when available, expected crop progress from historical data
- * expected crop spectral and agricultural field spatial properties
- * evidence from the scene



Crop Mapping

WA, USA:
07/20/2006



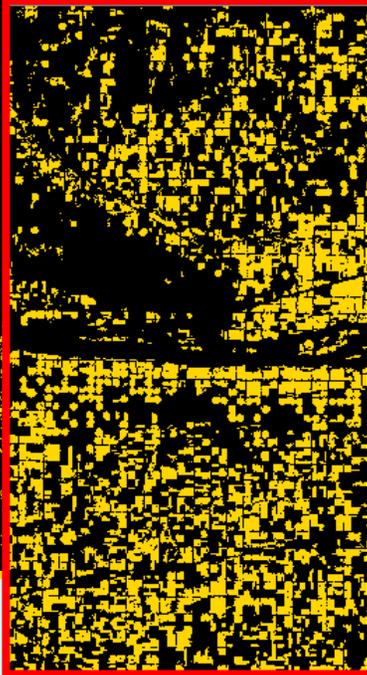
Classification Uncertainty: 20
Corn Posterior Probability: 87
S. Wheat Posterior Probability: 13



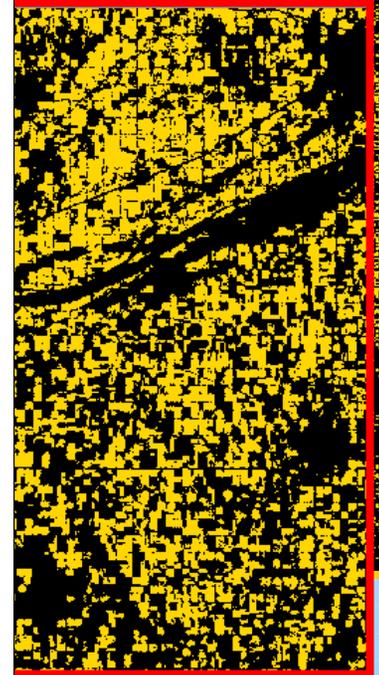
Crop Mapping

Nebraska 2006: Corn

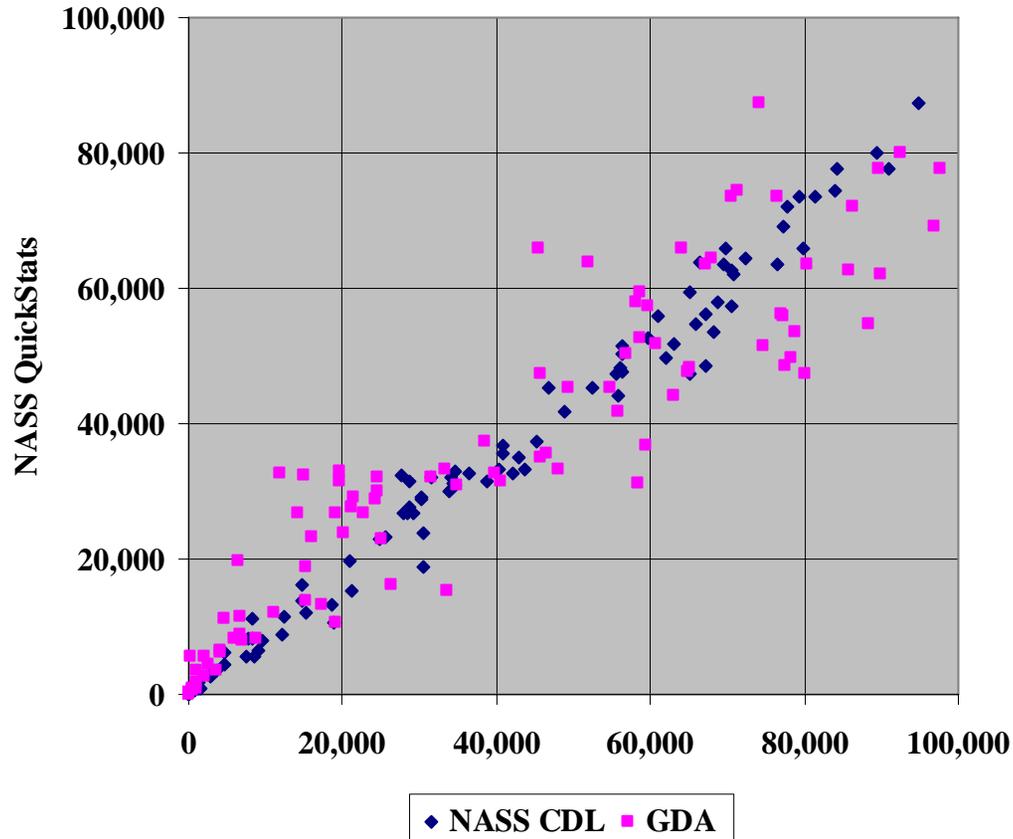
USDA NASS: CDL



GDA: RASTA



Nebraska Counties, 2006: CORN



Crop Area Stats

South Africa: 2007 Corn Estimates (Gauteng, RSA)

	Jan 23	Feb 05	Feb 14/15	March 01	March 10/11	March 20
Crop (ha)	136,368	138,236	137,406	62,696	66,023	53,900
Data Gaps* (%)	52	23	1	1	4	0
% Crop Area Change	0	+1	+1	-54	-52	-60

* Data Gap refers to the cropland areas under clouds, cloud shadows, and outside of the image footprint.

**End of February: MAJOR CROP FAILURE
with ~50% crop loss**



Provisional Products for the USA and RSA

- **Crop Classification Maps**
- **Crop Acreage Statistics**
 - **Locations and Stats for a dominant crop and 1-3 subdominant crops.**
 - **Particular focus on corn, soybeans, wheat, cotton, and rice.**
 - **Maps and Stats are provided for a scene, scene mosaic, an administrative area, or any AOI.**
 - **Can be generated for most of the USA and all of South Africa. Currently extending to Argentina, Brazil, and Australia.**
 - **Current turn around: 3 to 10 days per footprint.**



Provisional Products for any footprint

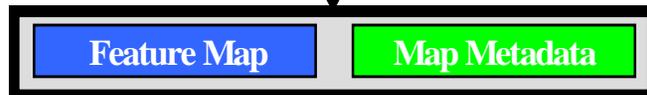
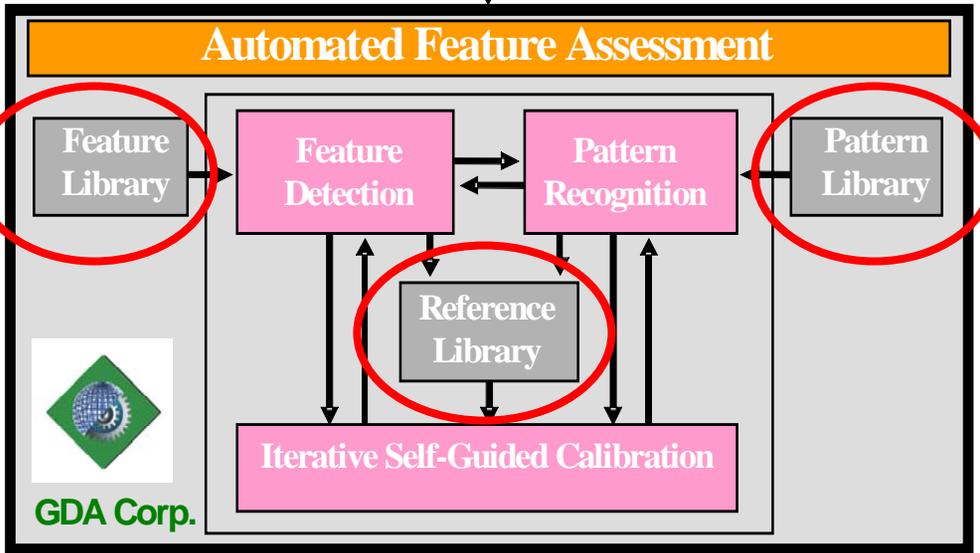
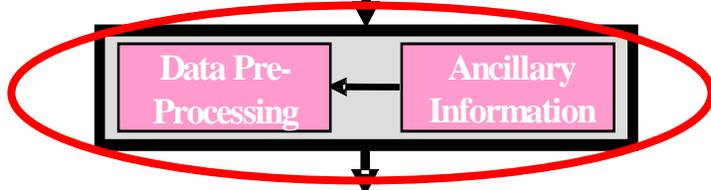
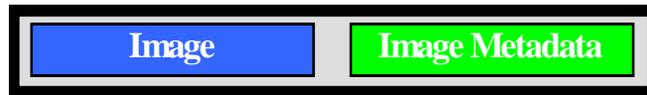
- **Cropland Status Maps**
- **Cropland Status Statistics**
- **Classes:**
 - ✓ **Bare soil (wet to dry soil classes),**
 - ✓ **Active/Green Crops (healthy to stressed and densely to sparsely vegetated),**
 - ✓ **Open Water,**
 - ✓ **Data Gaps (clouds, cloud shadows, dense haze, SLC-off)**
- **Maps and Stats are presented for a scene, scene mosaic, an administrative area, or any AOI.**
- **Current turn around: 2 to 7 days per footprint.**



Feature Detection with P6-AWiFS Imagery



GDA Feature Detection



Iterative Evidence / Knowledge Accumulation

- From Global to Scene Specific Knowledge Database
- Spectral
- Spatial
- Contextual / Pattern / Association

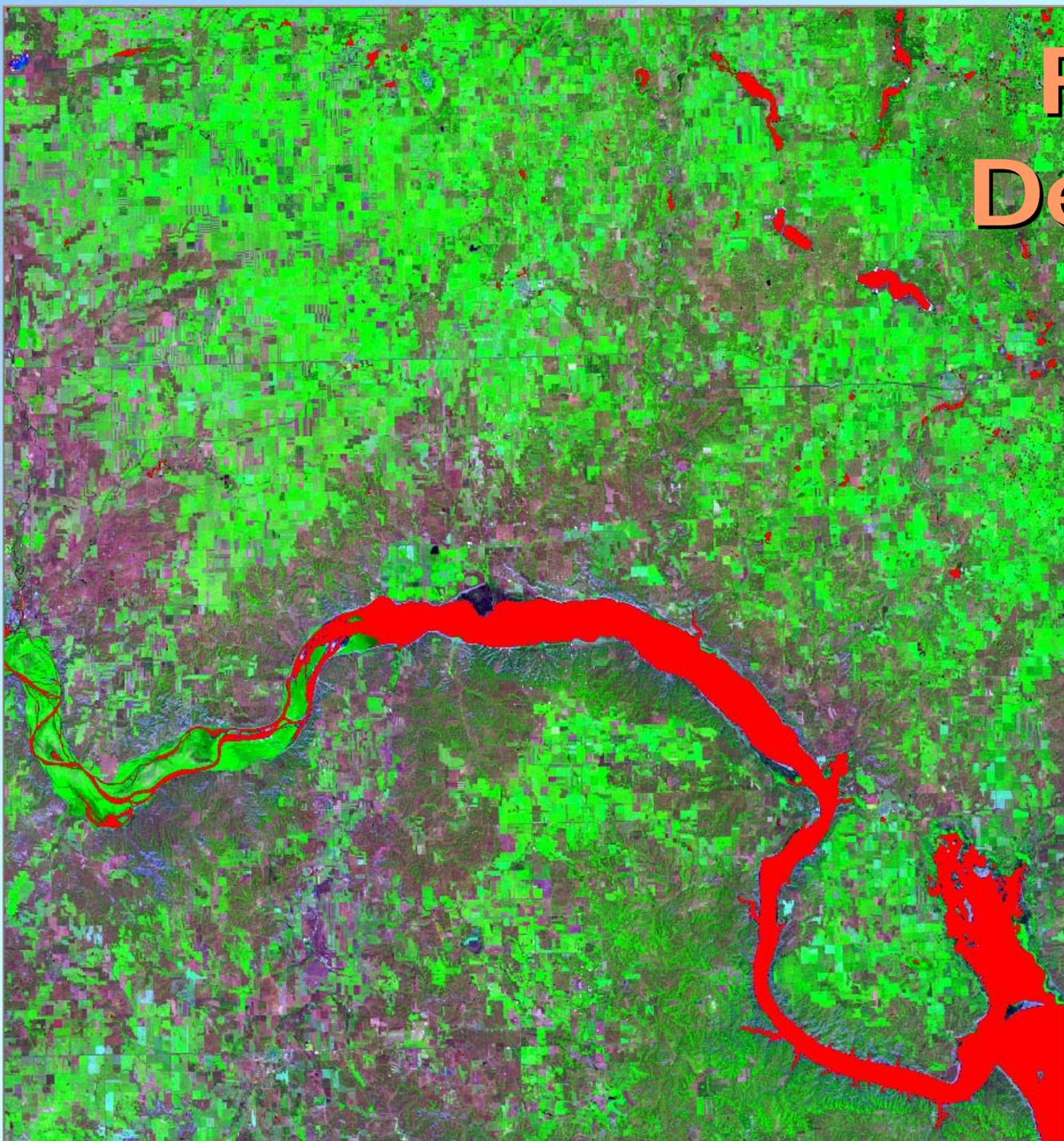
Probability Based

- per Pixel
- per Object

Flexible

- Can be set to be more or less “aggressive”
- Can work in an interactive mode





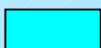
Feature Detection: Water

- Self-learning expert system
- Relies on a global knowledge base about water properties and extends global knowledge to the properties of a given scene
- If available, uses ancillary LC information as an extra line of evidence in the decision making process



Feature Detection: Clouds & Shadows

The same approach
is used as for water
detection

-  dense cloud
-  light cloud / haze
-  cloud shadow
-  water



Feature Detection: Snow/Ice

The same approach
is used as for water
and cloud / cloud
shadow detection

 Snow / Ice



Flood Mapping with P6-A WiFS Imagery



Flood Mapping

Goals:

To be able to rapidly and accurately detect flood events

To provide clients with spatial and statistical data on flood locations, extent, duration, and severity.



Flood Mapping

Identification of:

- **Areas of Flood / Inundation (with detectable standing water),**
- **Areas of Soil (Over)-Saturation (without detectable standing water)**

Analysis of:

- **Temporal Changes in Flood / Inundation and Soil Saturation**

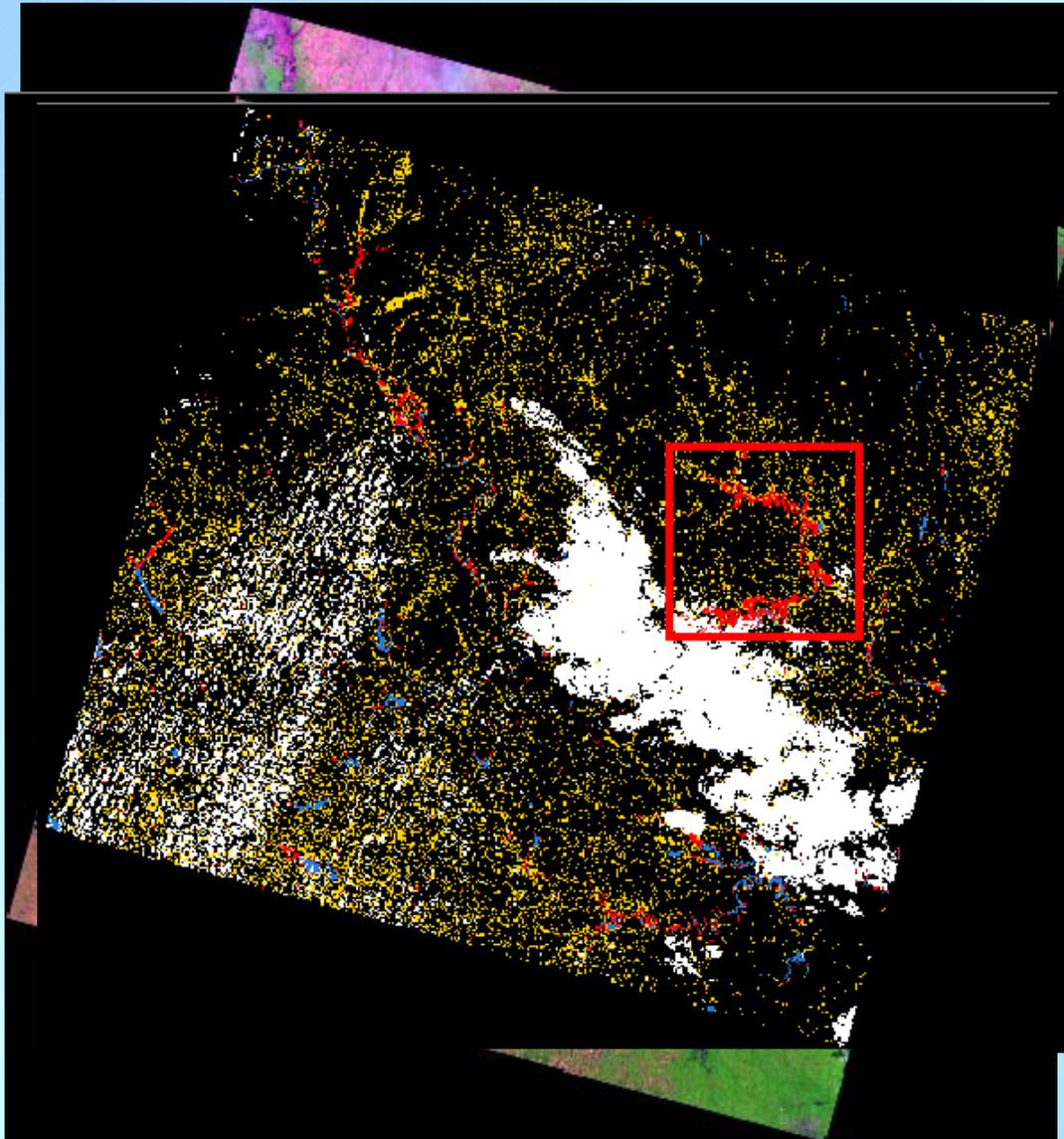
GDA performs automated mapping of water and wet soil and monitoring of their change with AWiFS and Landsat imagery.



Flood Mapping

central part of
South Nebraska

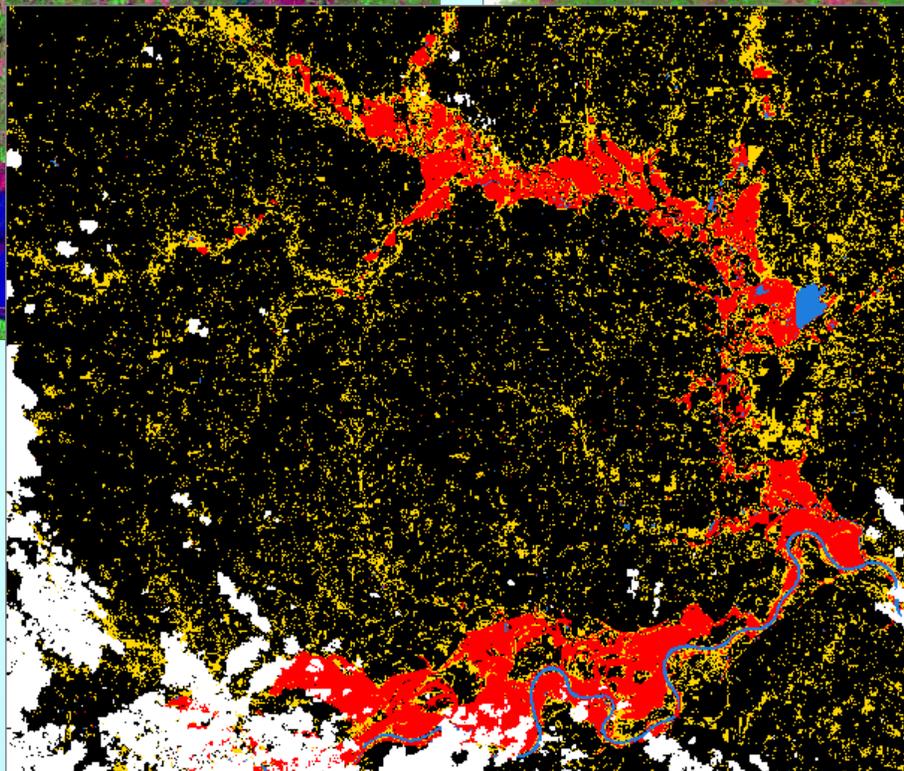
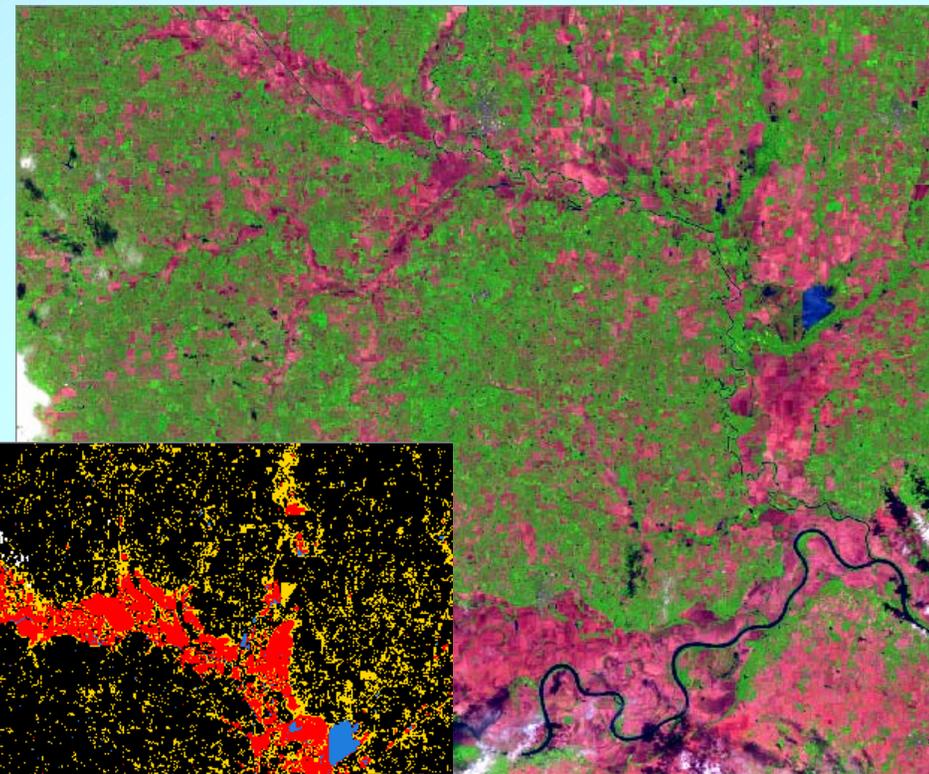
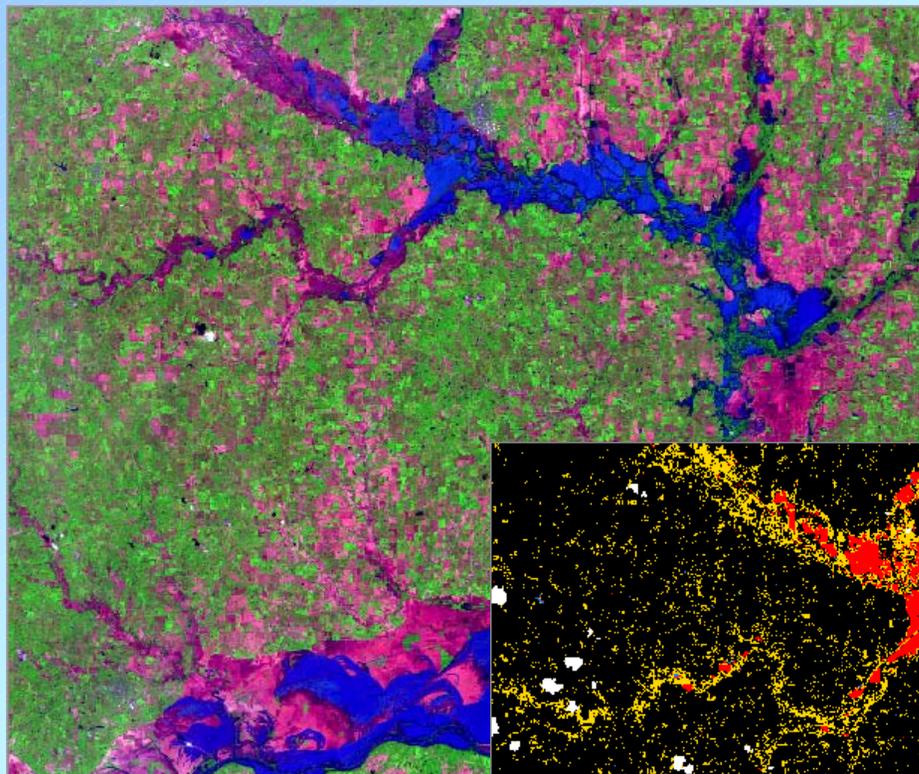
May 14 vs May 19, 2007



-  **Water: No Change**
-  **Flood Areas**
-  **Wet Soil: New Areas**
-  **Areas of Data Gaps**



Flood Mapping



May 14, 2007

May 19, 2007

-  Water: No Change
-  Flood Areas
-  Wet Soil: New Areas
-  Areas of Data Gaps



Contract Vehicle



GDA Corp. is a prime vendor on the Arctic Slope Regional Corporation Management Services Prime Vendor Contract for the USDA.



Please visit our Table-top display for more information.

THANK YOU!



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