Global Food Security: NGA and USDA Project Success
"New NGA–USDA Techniques Assess Harvest Yields – Project Expands"

Paper Number: 1031
by
Dr. Shawana P. Johnson
And Robert Tetrault

Abstract

The successful results of the Interagency collaboration between the National Geospatial-Intelligence Agency (NGA) and the U.S. Department of Agriculture (USDA) in predicting the Iraq drought early enough for Iraqi government officials to avert a famine by arranging for food shipments to the impacted areas led to an expanded four country follow on project in the 2008-2009 growing year and the 2009-2010 crop marketing year.

The goal of this next project was to develop new remote sensing processes for assessing crop health and predicting harvest yields in growing regions where minimal ground condition information is available by utilizing a three-tier data methodology and a convergence of evidence.

Human observations can never be replaced entirely, although high-resolution satellite imagery often used by NGA for intelligence purposes was integrated successfully into existing crop monitoring processing methodologies.
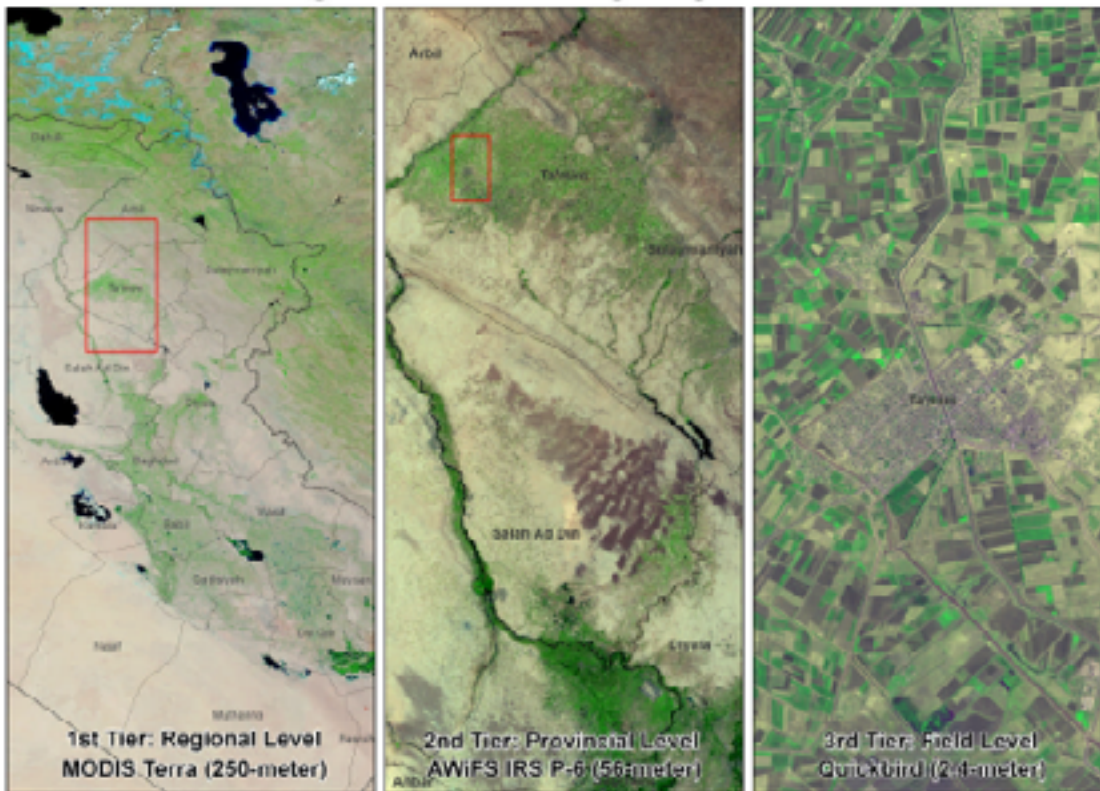
Project Overview

Following the success of a crop monitoring pilot in Iraq during the 2007/08 growing season, the USDA and NGA expanded the cooperative project to include Iran, Syria, and Afghanistan this year.

During the 2007–08 growing season, the Iraqi Ministry of Agriculture knew that wheat and small grain farms were in trouble in the country's normally plentiful northern region when the partnership between NGA and the USDA detected an impending drought early enough for Iraqi government officials to avert a famine by arranging for food shipments to the affected areas. The joint project successfully developed new remote sensing techniques for assessing crop health and predicting harvest yields in growing regions where the USDA lacked adequate ground condition information.

One reason the United States closely monitors international crop health is that a stable food supply is critical to the overall security of a nation. USDA evaluates and publishes information in its forecast of supply and demand for U.S. and global crops. USDA makes its production forecasts based on a convergence of evidence methodology, which involves volumes of structured and unstructured information, including low- and medium-resolution multispectral satellite imagery as well as meteorological data. This remotely sensed information is usually supplemented by reports from experienced observers located throughout the growing regions being monitored. However, in many locations, ground observers do not exist.

NGA provided high-resolution imagery to the USDA hoping to fill the information gap from low and mid-resolution satellite imagery.
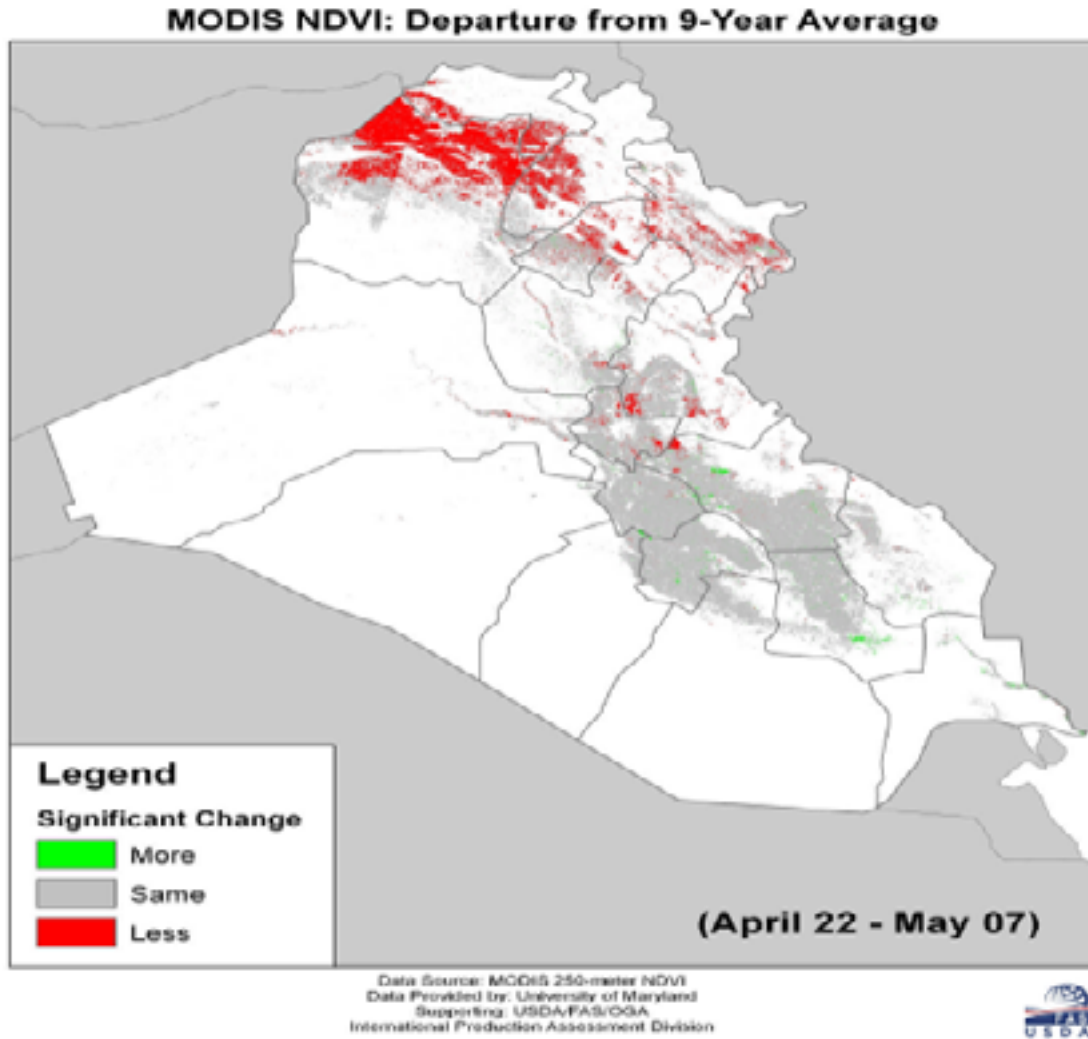
Three Tier Agricultural Monitoring: Regional to Local Scale

1st Tier: Regional Level
MODIS Terra (250-meter)

2nd Tier: Provincial Level
AWiFS IRS P-6 (56-meter)

3rd Tier: Field Level
QuickBird (2.4-meter)

Imagery Source: JACIE 2010 – Dr. Shawana P. Johnson

Multispectral Analysis with Multiple Satellite Sensors

NGA utilizes national remote sensing resources and commercial high-resolution satellite imagery from commercial vendors, such as Digital Globe and GeoEye. The USDA relies on low-resolution data from the NASA Moderate Resolution Imaging Spectroradiometer (MODIS) sensor and other systems and on medium-resolution imagery from Landsat and the Indian Advanced Wide Field Sensor (AWiFS).

MODIS NDVI: Departure from 9-Year Average

Legend

Significant Change

- More
- Same
- Less

(April 22 - May 07)

Data Source: MODIS 250-meter NDVI
Data Provided by: University of Maryland
Supporting: USDA/FAS/OGA
International Production Assessment Division
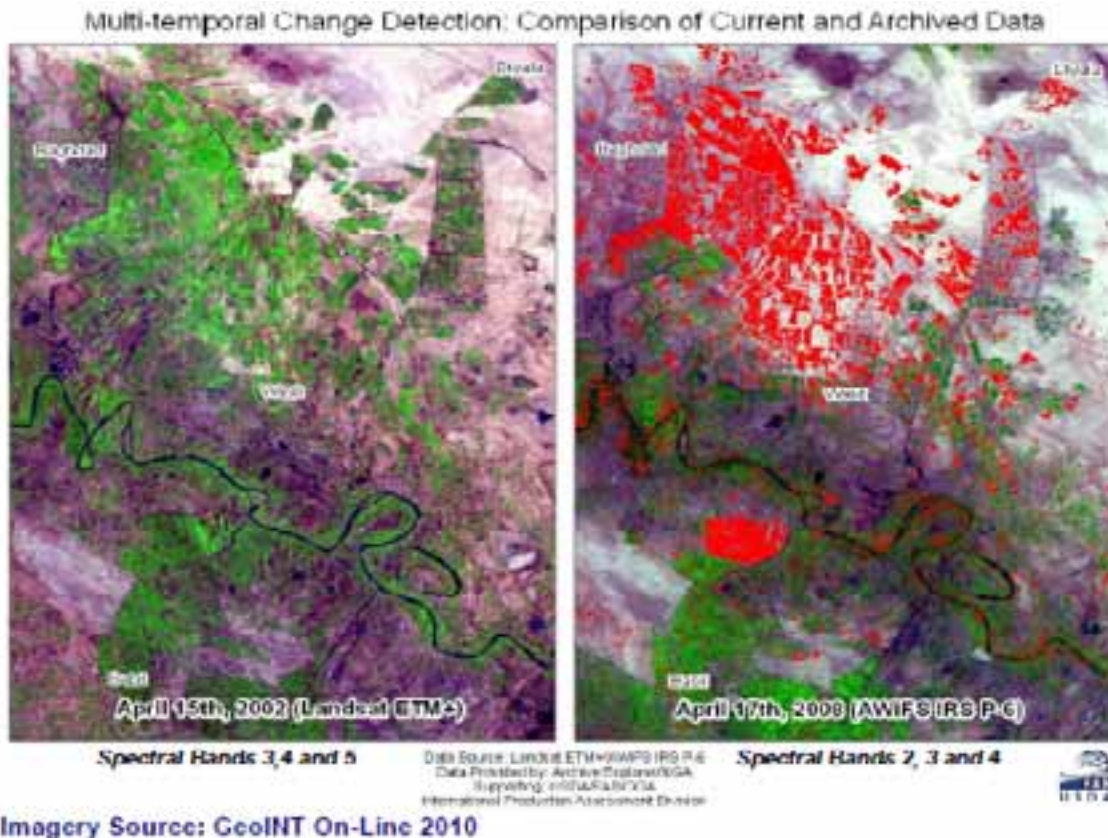
Imagery Source: GeoINT On-Line 2010

The coarse-resolution MODIS data provides precipitation information and vegetative abundance. With its large swath entire countries can be imaged frequently. The comparison of MODIS indices in the NASA archive from one year to the next in Iraq showed much lower vegetative yields.

Crop Abundance Image Comparison: MY 2000/01 to MY 2008/09
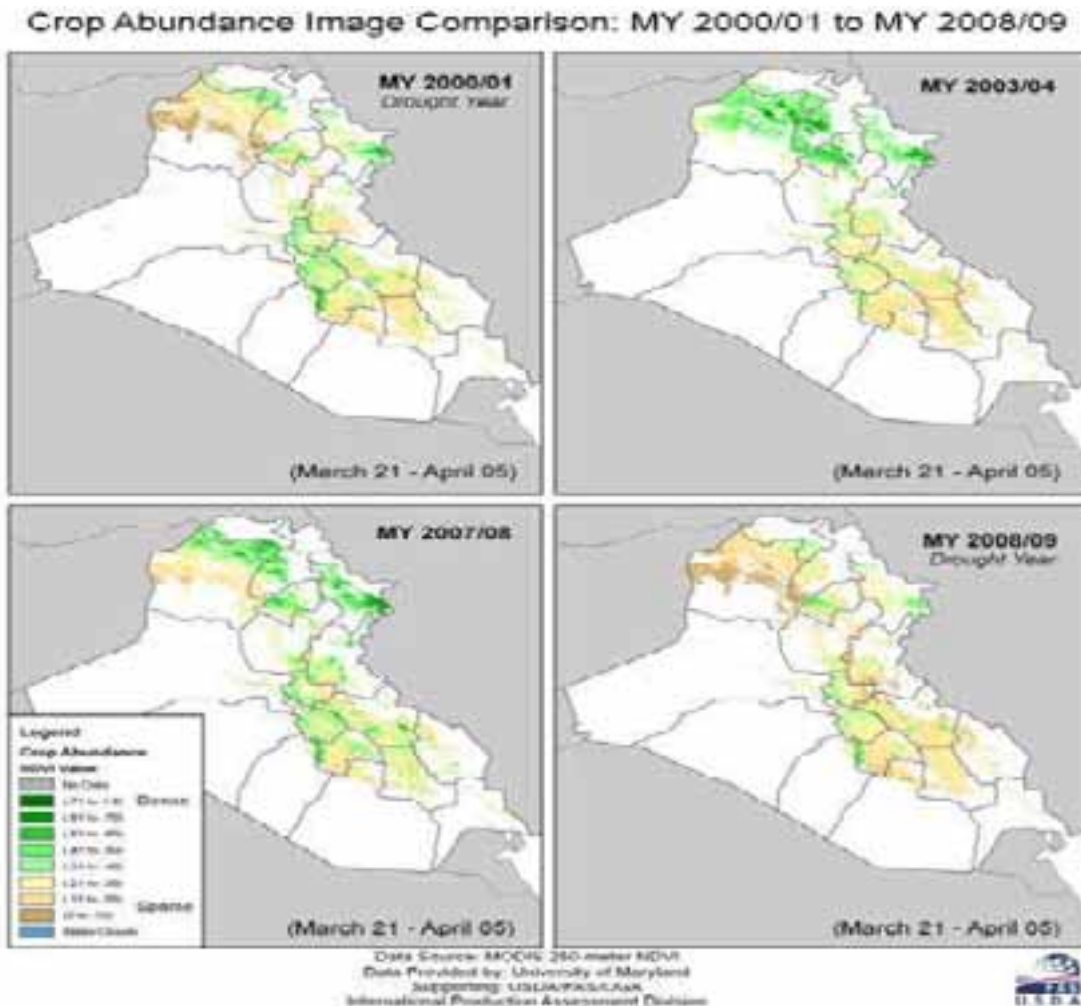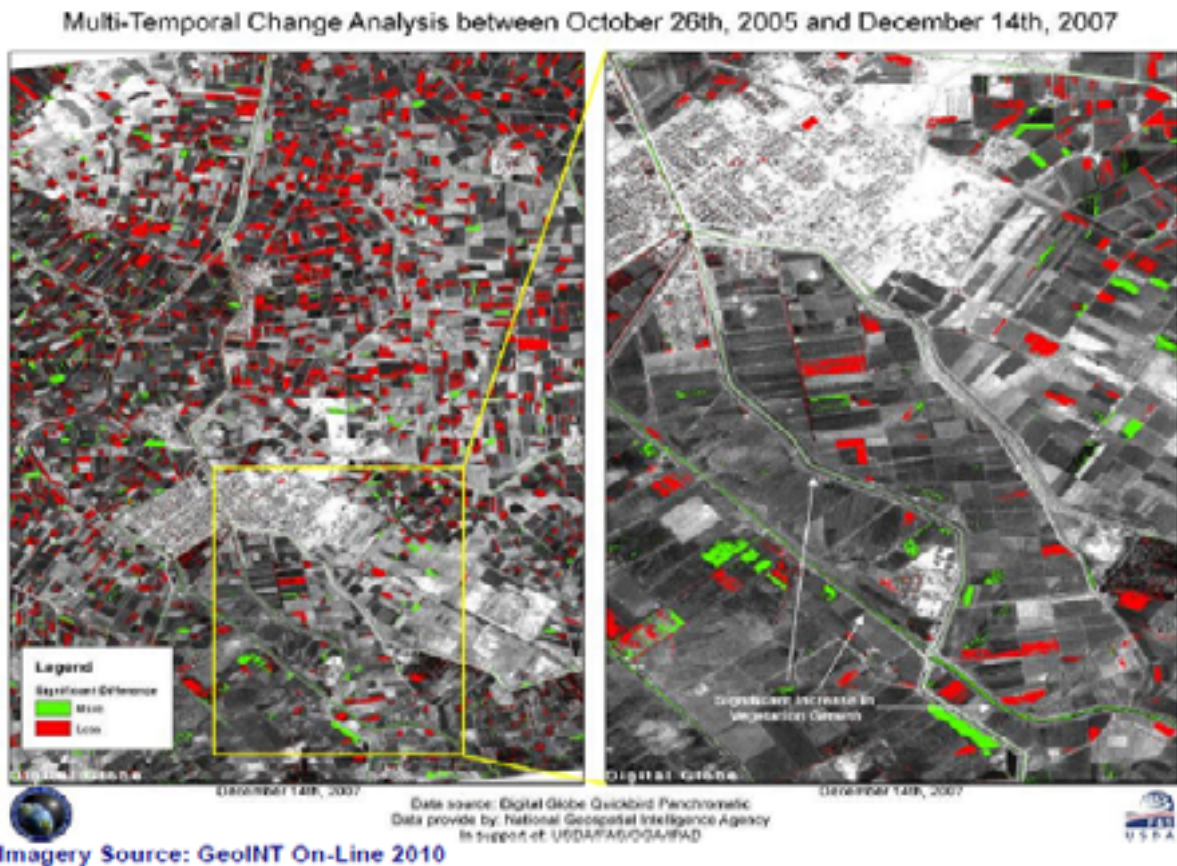

Imagery source: GeoINT On Line 2010

The next step in the process was to utilize AWiFS imagery from the Indian Resourcesat-1 satellite with its multispectral bands, 56-meter spatial resolution and 740-kilometer-wide swath with 5 day revisit for closer observation of wheat and grain producing areas. AWiFS sensor characteristics successfully monitor large area agricultural conditions. The AWIFS images indices demonstrated that the biomass growth was lower than that of previous years. In addition mid-resolution images of Landsat and AWIFS were compared through change detection and also demonstrated major changes in crop yield in the northern province of Iraq.

Multi-temporal Change Detection: Comparison of Current and Archived Data

April 15th, 2002 (Landsat ETM+) — Spectral Bands 3, 4 and 5

April 17th, 2008 (AWiFS IRS P-6) — Spectral Bands 2, 3 and 4

Imagery Source: GeoINT On-Line 2010

Once the Course and Mid-Resolution imagery demonstrated pending crop production shortages a field or ground observer would be needed to validate the findings. NGA instead provided high-resolution commercial satellite imagery of 18 farm locations in Northern Iraq acquired by DigitalGlobe's QuickBird satellite. The 2.5-meter resolution QuickBird images were captured at five different times during the growing season.

This high-resolution multispectral imagery provided details into what was happening in each field. The imagery differentiated wheat from other crops and revealed whether the fields were being currently worked. The QuickBird and AWiFS images which were acquired at about the same time were combined to demonstrate a sequence of crop growth.

Multi-Temporal Change Analysis between October 26th, 2005 and December 14th, 2007

Imagery Source: GeoINT On-Line 2010

As analysis continued and more data were utilized it became clear that Northern Iraq fields containing healthy wheat and other grains was well below normal, confirming the impending mid-season drought. The project partners promptly disseminated this information to U.S. and Iraqi officials in order to divert a food shortage disaster.

Refining the Process
NGA and USDA considered the pilot a success and NGA continued the project into the 2008–09 and 2009-2010 growing seasons with expanded activities. The project has developed many new remote sensing product techniques from cloud free mosaics to seasonality products utilized in conjunction with weather data for further drought information.

Conclusion
The NGA–USDA partnership helped detect and prevent a looming humanitarian crisis in Iraq. Many nations face similar food security issues. This interagency cooperative project combined expertise and data serving the United States and the global community while extending the U.S. Taxpayer dollar. Both agencies made investments with resources the other did not possess providing early warning techniques, provincial reconstruction team data and reservoir monitoring.

Based on the success of the pilot, NGA invited USDA to be part of GEOINT Online. In response, Global Marketing Insights, Inc. (www.globalinsights.com), a subcontractor for the USDA, created an Interactive Google Map on the GEOINT Online (www.geoint-online.net) website to illustrate the results of the Global Food Monitoring Effort. The GEOINT Online site provides access to existing NGA web-based capabilities for on-demand discovery of geospatial intelligence.

The Agricultural Monitoring page offers users a map interface that demonstrates how the combination of multi-resolution satellite imagery data provided early warning of the coming drought in Iraq and its impact on crops. Other related agricultural products and crop analysis data are added to the site regularly.
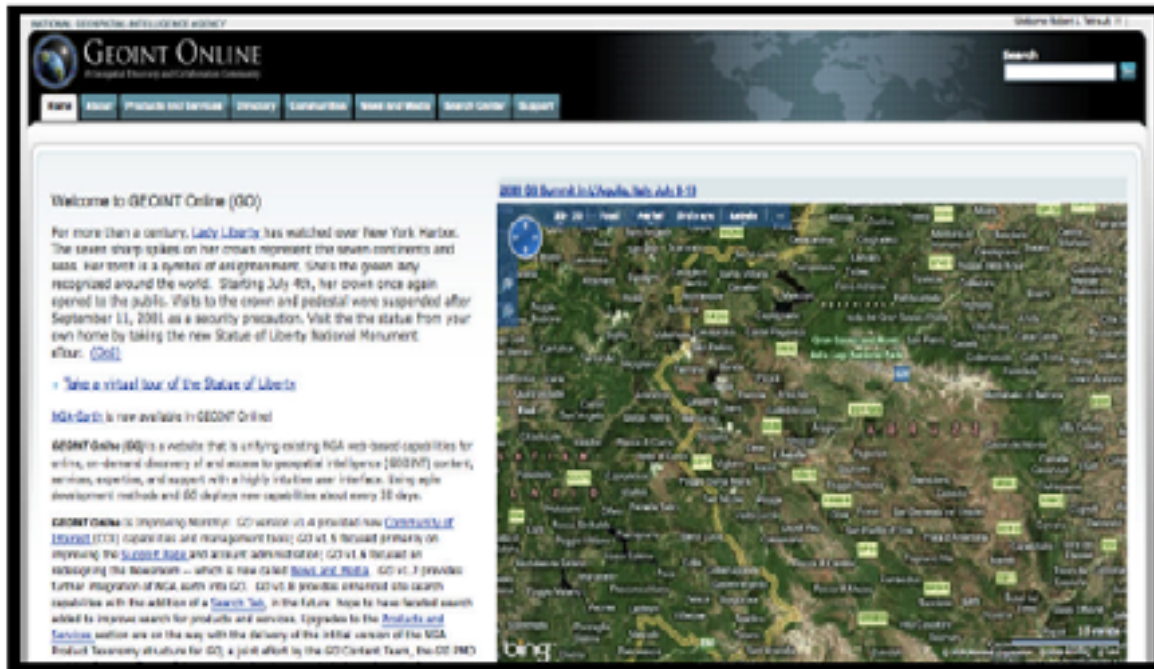

Image Source: Screen Shot, GO

To access the USDA FAS page on GEOINT Online, go to www.geoint-online.net, click on "Communities", select "GeoInt Data" and then choose "Iraq Agricultural Monitoring Project."

Acknowledgments
Global Marketing Insights, Inc. would like to thank NGA, USDA (especially Mr. Robert Tetrault – Project Manager), GCS Research, Inc. and Arctic Slope Regional Corporation, Corbley Communications and the satellite data providers for their role in the development of this paper.

References
Data Sharing Partnerships Session Moderator, "Successful Inter and Intra Agency Partnerships with the USDA and NGA"; ASPRS, San Diego, CA April 29th, 2010.

"Middle East Operational Agricultural Monitoring Project – USDA and NGA". JACIE, Joint Agency for Commercial Imagery Evaluation, Fairfax, VA, March 16th, 2010.

"Global Remote Sensing Market Research Availability" joint presentation with the USDA FAS, Robert Tetrault, Satellite Imagery Archive Manager, "Commercial Imagery Availability Global-Operational Usage", National Geospatial-Intelligence Agency, Commercial Community Imagery Forum, August 4th, 2009.

"Supporting Analysis of Agricultural with Imagery", Presentation with GDA Corp., ESRI International User Conference, San Diego, CA, July 14th, 2009.

"USDA and National Geospatial-Intelligence Agency –eGEOINT website featuring Iraq Agricultural Monitoring Project", ESRI International User Conference – Lightening Talk, July 13th, 2009

Author Information

Dr. Shawana P. Johnson, President of Global Marketing Insights, Inc. (GMI) since 1997. With over 20 years of experience in working directly in the remote sensing profession, with the USDA, and with agricultural and defense applications she leads GMI in being an industry leader in providing Global Geospatial Business Intelligence™ to both the public and private sectors.

Robert Tetrault, U.S. Department of Agriculture, Foreign Agricultural Service, developed and led this project effort with NGA which included the successful development and implementation of a Memorandum of Understanding between NGA and the USDA. Bob has over fifteen years experience in the application of remote sensing technology to agriculture in both the government and private sector. Bob was responsible for developing joint projects with both government partners and the commercial satellite imagery vendors. Bob's previous work experience includes business development at the commercial company Resource21 and for the FAS Office of Global Analysis as a crop analyst for Argentina and other parts of South America.

Global Marketing Insights, Inc.
6801 Brecksville Rd. Ste. 206
Independence, OH 44131
216-525-0600 phone
shawana@globalinsights.com
www.globalinsights.com

For information contact Sherry Loy in the Ohio Office, 216-525-0600,
 sherryloy@globalinsights.com .