Global Agriculture Monitoring

Seguimiento global de la agricultura

Surveillance globale de l'Agriculture

شاملة زراعة مونيتور

Глобальный сельскохозяйствен ный мониторинг

Globales landwirtschaftliches Monitoring

全球农业监测

ניטור חקלאות גלובלי

Monitoramento global da agricultura

Σφαιρική Αγροτική Παρακολούθηση

ग्लोबल एग्रीकल्चर मानिटरिंग

Monitoraggio globale dell'agricultura
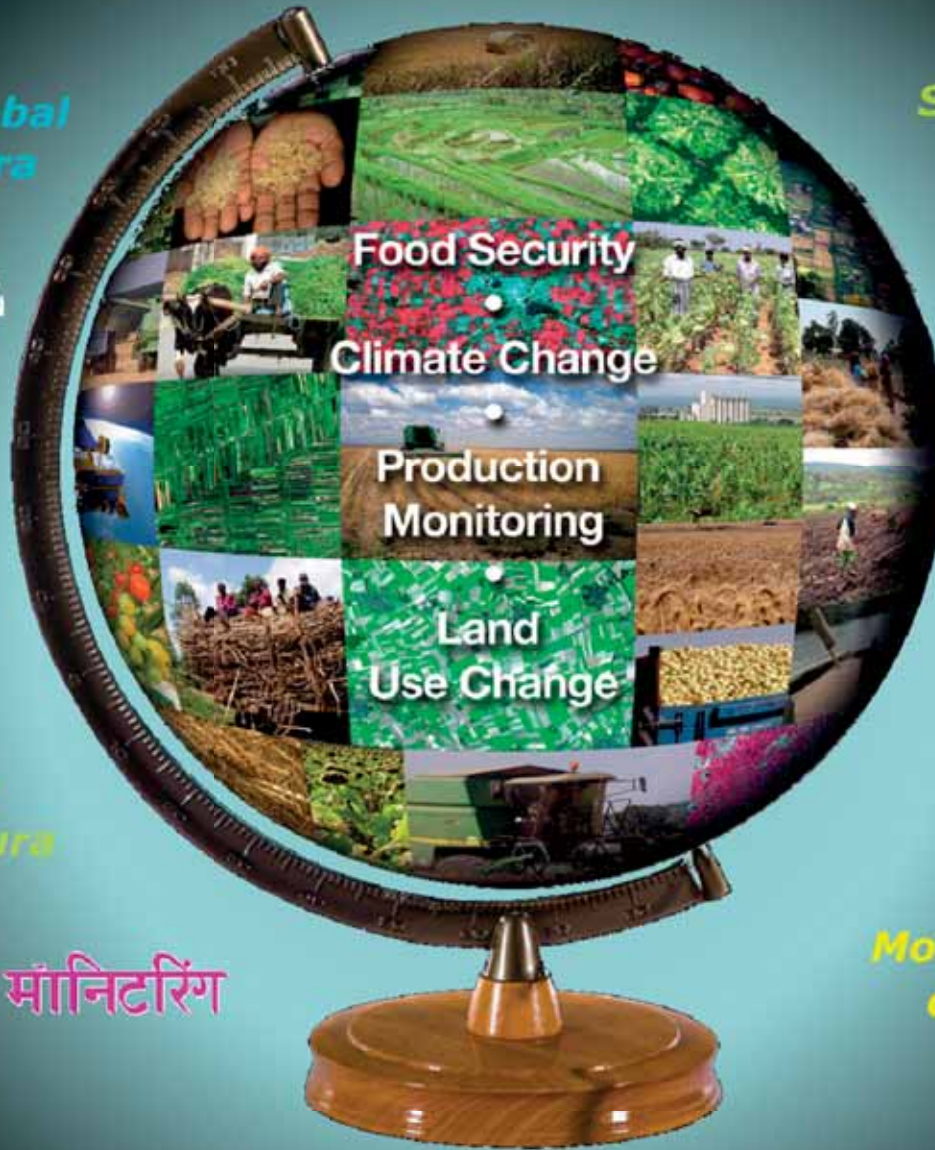
Food Security

Climate Change

Production Monitoring

Land Use Change

Global Agricultural Monitoring Community of Practice (GEO Task AG-07-03a)

GEO GROUP ON EARTH OBSERVATIONS

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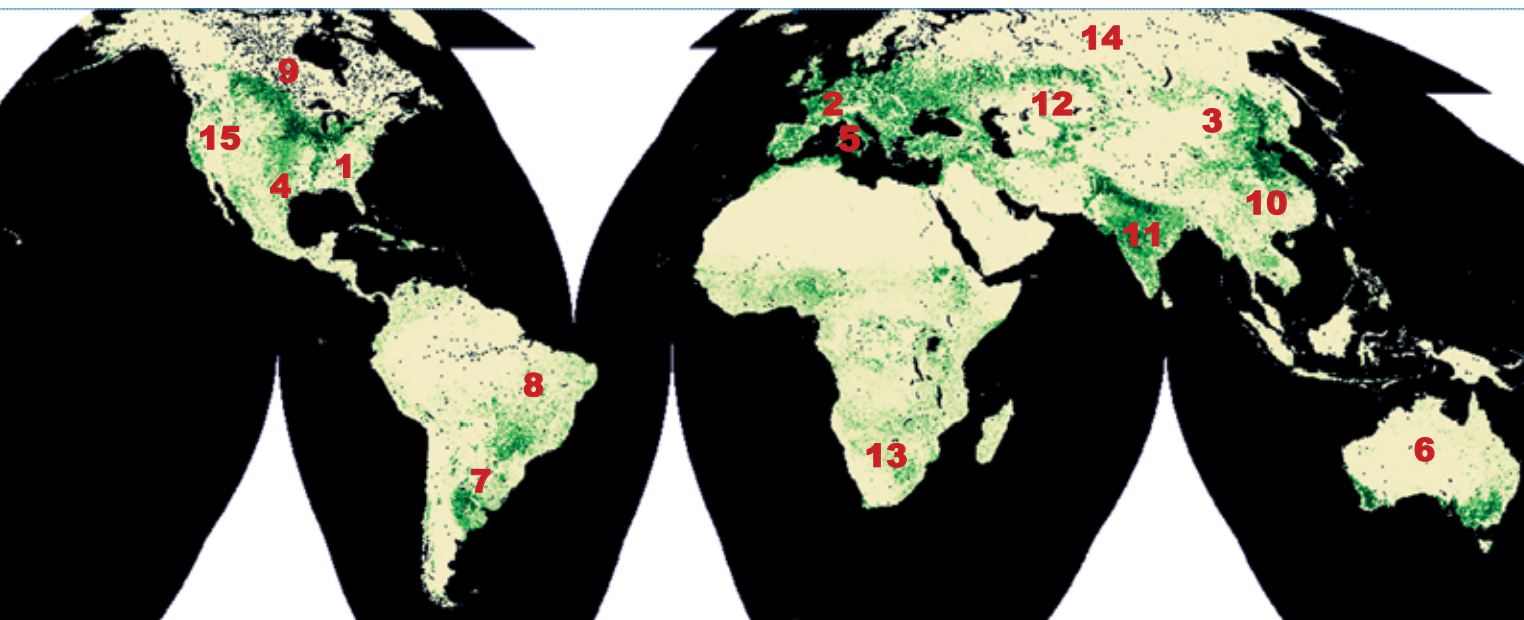PRINTED ON ELEMENTAL CHLORINE-FREE BLEACHED PAPER (ECF)

The purpose of this brochure is to provide an overview of the GEO Global Agricultural Monitoring Task and the associated Community of Practice (GEO AG-07-03).
The Global Agricultural Monitoring Task addresses four primary themes: crop production forecasting, famine early warning, agricultural land use change, and impact of climate change. It doesn't address directly the applications at the individual farmer or parcel level, such as crop monitoring for precision farming or controls in agriculture for verification purposes.

The 15 examples of agricultural monitoring systems presented in this brochure are a representative sample of the GEO Agricultural Monitoring Community of Practice. Many other countries and organizations, not mentioned in this brochure, have set up earth observation systems for crop monitoring and production forecasting. For example, regional centers such as AGRHYMET in west Africa and SADC in Southern Africa produce regular information for Early Warning.
A number of private companies offer various services concerning Agricultural Monitoring in Europe and North America.

2

Contents

Global Monitoring

1. FAS – USDA, USA
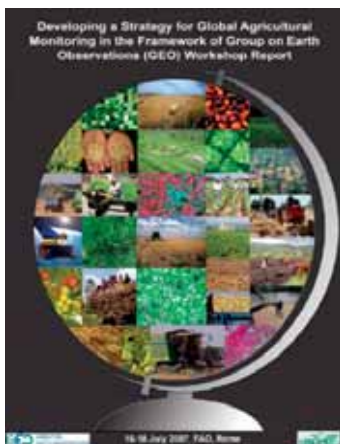2. MARS JRC, European Commission
3. Crop Watch – CAS, China

Early-Warning Systems

4. FEWS net- USAID, USA
5. GIEWS - UN FAO, Rome

National Monitoring

6. CSIRO - Australia
7. SAGPyA - Argentina
8. Geosafras CONAB - Brazil
9. CCAP – Canada
10. CHARMS - China
11. FASAL - India
12. NCRST - Kazakhstan
13. ARC - NCSC– South Africa
14. IKI's - Russia
15. NASS USDA - USA

Global Cropland Extent from Multi-year MODIS Data, SDSU. *From Pittman K., Hansen M., Becker-Reshef I., Potapov P., Justice C. (2010). Estimating Global Cropland Extent with Multi-year MODIS Data, Remote Sensing.*

GEO Agricultural Monitoring Task

The Group on Earth Observations (GEO)[1] is a voluntary partnership of governments and international organizations, established in 2005 to coordinate earth observations with an emphasis on Societal Benefits, optimizing the use of the present observing systems, addressing current shortcomings and guiding the development of future improvements. The components of the observation systems are provided by different nations. The goal of GEO is to connect the various components into a Global Earth Observing System of Systems (GEOSS). The work plan of GEO is organized around a number of tasks. **The GEO Agricultural Monitoring Task (Ag-07-03)** falls within the GEO Agriculture Societal Benefit Area and has three related components – Global Agricultural Monitoring 07-03a, Agricultural Risk 07-03b and Capacity Building 07-03c.

The GEO Global Agricultural Monitoring Community of Practice (CoP) was established in 2007 at a meeting at the UN FAO in Rome. The community is open to all groups involved in the various aspects of agricultural monitoring. The CoP developed a common vision for the task under four themes [2]:

- Global monitoring of agricultural production, facilitating reduction of risk and increased productivity at a range of scales, timely and accurate national (sub-national) agricultural statistical reporting;
- Effective early warning of famine, enabling a timely mobilization of an international response in food aid;
- Global mapping, monitoring and modeling of changes in agricultural land use, type and distribution, in their social and ecological context;
- Monitoring and forecasting impacts of climate change on agricultural production and agricultural land use change.

The CoP is charged with defining the observation requirements for global agricultural monitoring system of systems, establishing the enabling conditions under which such a system can operate and undertaking activities leading to improvements in the current systems. These activities are currently grouped under four sub-tasks described at page 26 of this brochure.

(1)   The GEO Home page – http://earthobservations.org/

(2)   2007 Workshop Report - http://earthobservations.org/documents/cop/ag_gams/200707_01/20070716_geo_igol_ag_workshop_report.pdf

Agriculture Monitoring

Agriculture monitoring is not a new concern: The basics of Geometry and Land Survey were developed in ancient Egypt, to assess the cultivated areas effected by the fluctuating floods of the River Nile, with the purposes of taxation and preventing famine. The use of Earth Observation (EO) confirms that this application still requires the best technologies to provide more timely, objective and accurate agricultural information over wide areas.

The LACIE (Large Area Crop Inventory Experiment) was one of the first experiments to demonstrate the operational capabilities of Remote Sensing technology for Wheat production forecasting (Mac Donald and Hall, 1980). For 20 years, innovative programs such as AgRISTARS (USA, 1980 –85)[1], MARS (Europe, 1988)[2] and FEWS Net (USA 1985)[3] paved the way for further development of present operational systems using EO for crop monitoring and yield forecasting around the World, in developed countries and for Early Warning Systems in food-insecure areas.

The assessment of two components of crop production (yield and area) can benefit from the whole range of available EO systems which can provide: area estimates, bio-physical indicators, meteorological data and seasonal forecasts, that can be integrated into appropriate crop development or statistical models. This is currently an area of rapid research and development, with new technologies and methods being applied to significantly enhance existing systems and provide new operational capabilities.

The recent food-price crisis has put Agriculture back on the top of political agendas and at the juncture of various policies addressing world trade, food security, sustainable development and eradication of poverty. These are all closely interlinked in a global challenge to feed 9.1 Billion people by 2050, requiring almost a doubling of the present agricultural production in order to reach the 1st Millennium Development Goal.

Agricultural production systems must be enhanced and made sustainable to reach this challenge. More reliable, detailed and timely information on crop area, yields and agricultural land use will be required to manage agriculture and address competing pressures on agricultural systems, such as the growth in the demand for bio-fuels, urban expansion, competition with other natural resources, environmental quality, biodiversity and climate change. Efficient agricultural models offer a viable significant contribution to explore the future impacts of climate change, identify optimal adaptation strategies and the possible role of agriculture in greenhouse gas mitigation.

The GEO Agricultural Monitoring Task provides a much-needed framework for a concerted international effort to improve global agricultural monitoring for the benefit of society. To overcome the challenges facing global agriculture, national governments and international organizations and agencies will need to make an unprecedented commitment for coordination of observations and cooperation to enhance the current capabilities and their utilization and ensure long-term observations.

Jinlong Fan (Agricultural POC, GEO Secretariat), Jai Singh Parihar (Executive Director GEO Ag-07-03),
Chris Justice, Wu Bingfang, and Olivier Léo (Co-chairs)

(1) AgRISTARS: Agriculture and Resources Inventory Surveys Through Aerospace Remote Sensing (USDA –NASA Johnson Space Centre)
(2) MARS: Monitoring Agriculture with Remote Sensing – Joint Research Centre of the European Commission, ISPRA
(3) FEWS (Famine Early Warning System) of the USAID- USGS- NASA NOAA and various partners

The Foreign Agricultural Service (FAS) of the U.S. Department of Agriculture (USDA) works to improve foreign market access for U.S. products, build new markets, improve the competitive position of U.S. agriculture in the global market place, and provide food aid and technical assistance to foreign countries. The FAS has the primary responsibility for USDA's international activities - market development, trade agreements and negotiations, and the collection and analysis of statistics and market information. The FAS also has food aid programs and helps to increase food aid availability in developing nations by mobilizing expertise for promoting agricultural economic growth.

Objectives: The primary mission of the International Production Assessment Division (IPAD) of the FAS Office of Global Analysis (OGA) is to collect, analyze, and disseminate global crop condition and agricultural production information.

Data Used: IPAD relies on an "all data sources" and "convergence of evidence" approaches by incorporating information from:

- Daily weather data (i.e., precipitation and minimum/maximum temperature) from the World Meteorological Organization station network and the US Air Force Weather Agency (AFWA) satellite-derived products;
- Vegetation Indices (VI) from low resolution satellite imagery (MODIS, SPOT-VGT, and AVHRR);
- Crop models for soil moisture, crop growth calendars, winterkill and relative yield reduction;
- Crop travel by FAS attachés and IPAD crop analysts;
- Economic data from official government reports, trade and news sources, and econometric analyses.
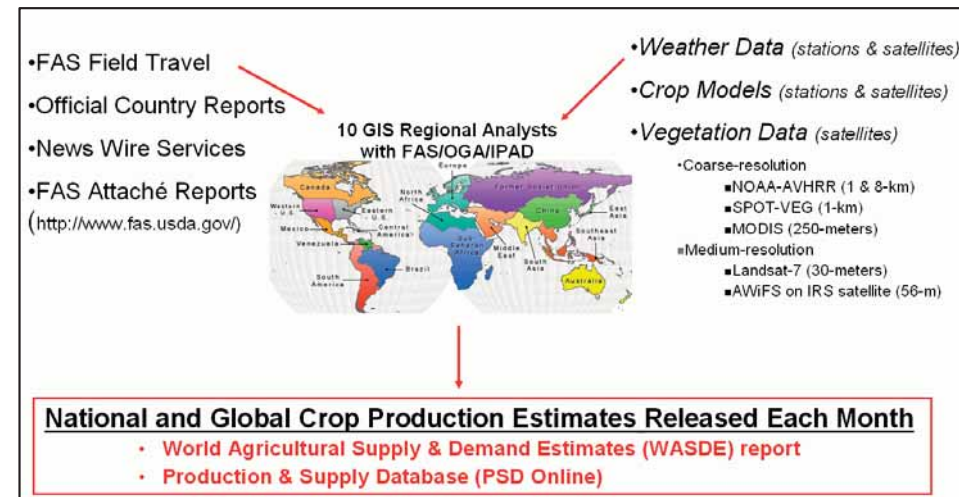
Procedures: Official crop statistics from other nations are critical in forming current crop estimates for the **World Agricultural Supply and Demand Estimates (WASDE)** report, but in practice, not all countries have crop-estimating agencies capable of making reliable, timely, or objective production forecasts. Also, many major producing and trading countries do not publish crop reports until well after the crop has been harvested. In the interim, USDA must monitor global precipitation, temperature, NDVI (Normalized Difference Vegetation Index) and other parameters over major crop producing regions that are economically important to the United States trade.
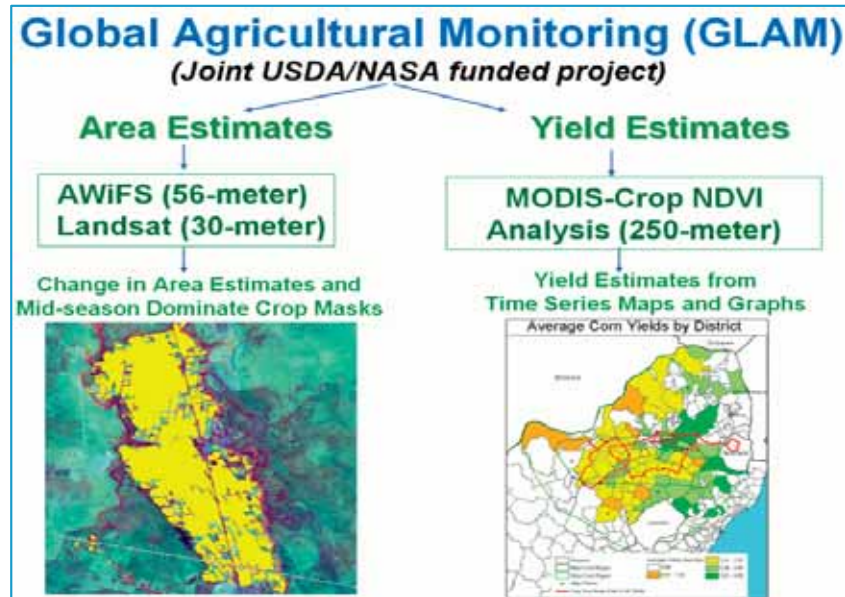
By comparing current weather and crop conditions with historical weather and crop yield data, the WASDE report provides American producers and commodity traders with free and equal access to reliable global crop supply and demand information commonly used by most major commodity markets.

The joint funded USDA - NASA **Global Agriculture Monitoring (GLAM)** project provides near-real-time, global remotely sensed data, data products and analysis tools that are used to operationally track crop conditions as the growing season develops, estimate relative crop yields and percent change in dominate crop area from year to year.

Global Agricultural Monitoring (GLAM)
(Joint USDA/NASA funded project)

Area Estimates — **Yield Estimates**

AWiFS (56-meter)
Landsat (30-meter)

MODIS-Crop NDVI
Analysis (250-meter)

Change in Area Estimates and
Mid-season Dominate Crop Masks

Yield Estimates from
Time Series Maps and Graphs

Average Corn Yields by District

Crop assessment survey conducted in Ethiopia, Oct. 2008

Results: USDA's monthly **WASDE** report and the **Production Supply and Distribution (PSD) database** form the foundation of USDA's global economic information system. The WASDE report is essentially a timely and monthly audit of national crop statistics collected from around the world and it serves as an objective, reliable, and accurate benchmark of current global crop supply and demand for use by commodity markets, traders, producers, and government policy makers. The PSD Online database provides current and historical official USDA data on production, supply and distribution of agricultural commodities for the United States and key producing and consuming countries.

Partners :
- **USDA's World Agricultural Outlook Board (WAOB)**
- **USDA's Joint Agricultural Weather Facility (JAWF)**
- **USDA's Agricultural Research Service (ARS), Hydrology & Remote Sensing Laboratory (HRSL)**
- **University of Maryland's Geography Department**
- **University of Maryland's Earth System Science Interdisciplinary Center (ESSIC)**
- **NASA's Goddard Space Flight Center (GSFC) Hydrological Science Branch (HSB) NASA's Global Inventory Modeling & Modeling Studies (GIMMS) at GSFC**
- **NASA's Earth Science Division**
- **Arctic Slope Regional Corporation (ASRC)**
- **Geospatial Data Analysis (GDA) Corporation**

To know more?

• **Visit:** http://www.fas.usda.gov/
or http://www.pecad.fas.usda.gov/

• **Contact:**
Derrick Williams, Derrick.Williams@fas.usda.gov

Curt Reynolds, curt.reynolds@fas.usda.gov

The MARS Project of the Joint Research Centre of the European Commission started in 1988. Since 1993, the MARS Project is running a crop yield forecasting system for the quantitative assessment of the major crops in European Member States. Since 2000, this expertise has been applied outside the European Union to cover the EU neighboring countries, and services have been developed to support Europe Aid and Food Security policies.

Objectives: The MARS Unit provides scientific and technical support to EU Agriculture and Food Security policies. A first core activity (AGRI4CAST) is centered on the provision of timely crop yield forecasts for the major crops in Europe and neighboring countries as well as in strategic areas of the world. A second core activity (FOODSEC) monitors crop development to provide early warning information and forecast crop production in vulnerable food insecure regions. It also provides technical support to Food Security Information projects financed by the European Commission, many in Africa.

Data used: MARS' crop monitoring / forecasting activities are based on:
• Low resolution high frequency remote sensing products: NOAA-AVHRR, SPOT VEGETATION and MODIS, received ten-daily with world coverage. An archive of remote sensing data which concerns Europe is also maintained with data since 1981.
• Meteorological information received daily from ECMWF models and from more than 4000 synoptic stations in Europe and Africa, or derived from METEOSAT satellite. More than 30 years of data archived.
• Additional geospatial information: Soil maps, land cover/land use maps (AFRICOVER, CORINE, GLC 2000, GLOBCOVER), information on crop calendar, phenology and agricultural statistics.

Remote Sensing infrastructure

Meteorological infrastructure

Vegetation state & meteo indicator since 1981 Europe, 1998 worldwide

Worldwide ECMWF data + archive Observed ground data since 1975 Europe under construction for Africa

Crop assessment Yield forecasts

Statistical infrastructure

Crop Model infrastructure

Time series regression, similarity analyses, etc

Qualitative: Bulletins and Early Warning

Quantitative: Yield forecasts

Agromet. indicators derived from crop-growth models: WOFOST /LINGRA /WARM or GWSI

Procedures: MARS systems combines both agro-meteorological modeling and remote sensing information to monitor the main crops. Remote Sensing Indices are extracted every ten days on agriculture areas using the C-NDVI technique on SPOT VGT 1 km resolution data. The quantitative crop yield forecasts are based in Europe on the simulation of several crop growth models implemented within the **MARS Crop Yield Forecasting System (MCYFS),** namely WOFOST, LINGRA and WARM.
FOODSEC generally runs Water Satisfaction Model based on meteorological data to produce several crop conditions' indices. During the agriculture season, crop qualitative assessments are produced based on anomalies between the crop development profiles of the current year and the profiles of historical or previous years. Before the end of the season and for some countries, quantitative crop production estimates are forecast using regression models calibrated with historical agricultural statistics: Simple models using NDVI or multiple regression using Water Satisfaction Indices and NDVI.

"Chronos" products from EO have promising application (similarity year analysis)
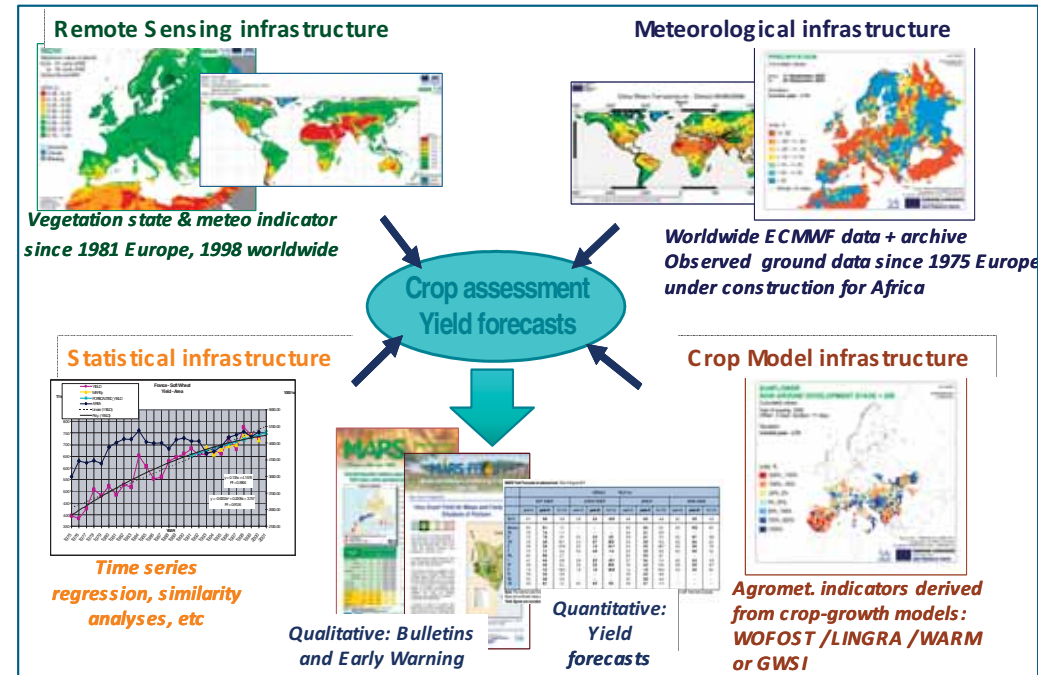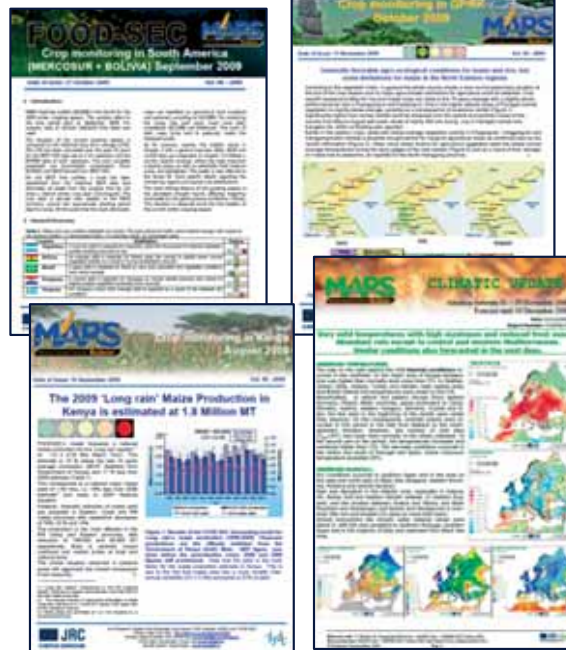
Examples of MARS bulletins
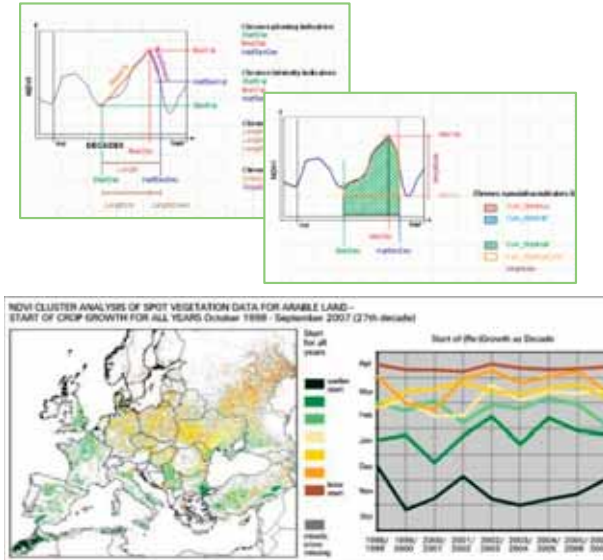
Results:

• Monthly or bi-monthly climatic and crop monitoring bulletins for Europe with quantitative yield forecasts by country.
• Monthly national / regional crop monitoring bulletins for Food insecure regions including qualitative and possibly quantitative estimates.
• WEB platforms for presentation and dissemination of the main data and information products (MARSOP)
• Regions and countries covered in 2009 for different sets of target crops include: European Union, Ukraine, Belarus, Russia, India, China, South America (MERCOSUR countries and Bolivia), Horn of Africa and Mediterranean region.

Partners:

• EU Directorate General for AGRICULTURE, EUROSTAT
• EU Member-States Administrations
• EU Directorates General DEV and RELEX, AIDCO (EuropeAid and Cooperation office)
• United Nations FAO and WFP
• ALTERRA (NL), VITO (Be), MeteoConsult (NL), GISAT (CZ)
• European Universities
• MARS maintains working relations through collaborative agreements with a number of institutions in the several countries among which USA, Brazil, Argentina, China, India, Morocco

To know more?

• Visit: http://mars.jrc.ec.europa.eu/

MARS data portal, http://www.marsop.info/marsop3/

• Contact:
Bettina Baruth (Agri4cast), bettina.baruth@jrc.ec.europa.eu
Olivier Leo (FoodSec), olivier.leo@jrc.ec.europa.eu

9

With about 20 years of research experience, the Institute of Remote Sensing Application (IRSA) of the Chinese Academy of Science (CAS) developed the CropWatch System in 1998 and has operated it ever since.
CropWatch covers China and 26 major grain-growing countries of the world. The system monitors crop conditions and production, drought, crop planting structure and cropping index. CropWatch currently publishes 7 monthly bulletins and 20 newsletters annually. The provision of timely and accurate information helps Chinese governmental departments and organizations to make sound decisions.

CropWatch structure

Data used:

• *Remote sensing data*: MODIS, 250 m for China and 1 km at global scale, Resourcesat-1 AWiFS, 56 m, B-J CCD, 32 m, Landsat TM 30 m, ENVISat ASAR 30m, Radarsat-1 ScanSAR, CBERS-01/02 20 m.
In the early period of CropWatch NOAA AVHRR and SPOT vegetation data were used. Currently data from Chinese Satellite HJ-1 are also ingested into the system.
• *Geo-spatial data*: landuse / landcover data of China, 1:100,000., GLC 2000 landcover data, 1 km, global crop phenology data.
• *Other data*: global meteorological data for agro-meteorological; condition assessment; field observation data in experimental plot for validation.

Methodology:

• For crop condition monitoring, CropWatch uses two models based on snapshot and crop growing process;
• For drought monitoring, RS based vegetation indices are computed and used in a crop drought model;
• For crop yield estimation, four models are run, namely: the agro-meteorological model, the remote sensing index model, a combination of both, and the biomass model;
• For crop acreage estimation, a new method is used, integrating remote sensing technology with ground sampling.
• For grain production estimation, changes relative to average grain yields and planted area are evaluated.

Crop condition monitoring

Drought monitoring

Crop yield monitoring

Crop acreage estimation

10

GVG field sampling system

GIS VIDEO GPS
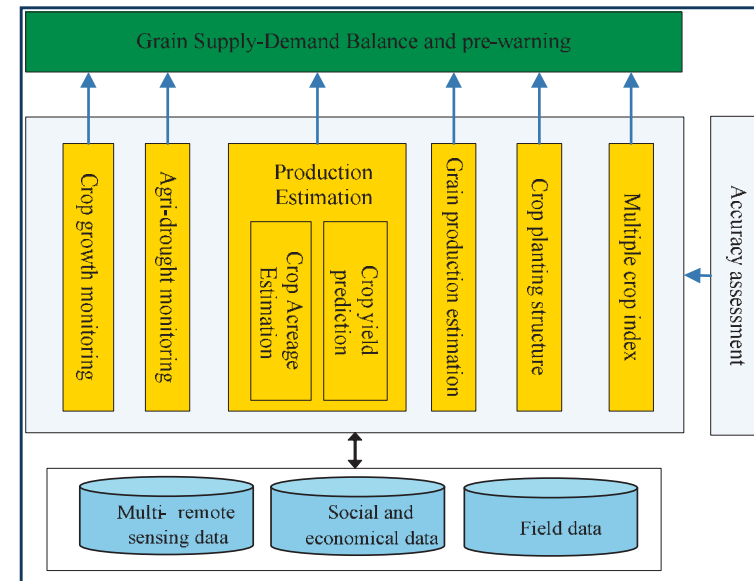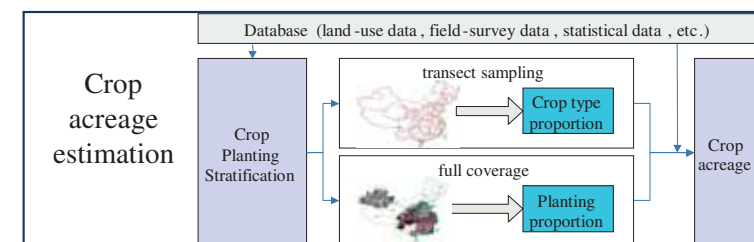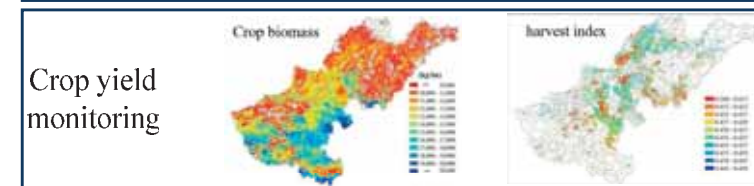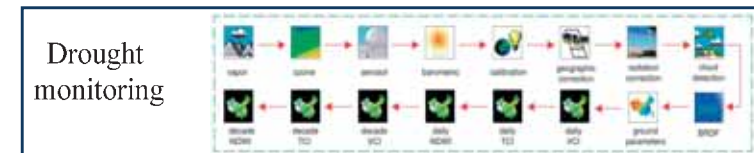
• For crop planting structure inventory, a GVG sampling instrument was developed to survey the proportion of different crops in planted farmlands;
• For cropping index monitoring, a estimating model based on the reconstructed crop growing profile and the counting of peaks in the profile was developed.

Results:
• Crop condition monitoring in China (10-day interval) and 26 major agricultural countries (monthly)
• Drought monitoring result in China (10-day interval)
• Crop yield and crop production of China and 26 major agricultural countries (monthly)
• Crop planting structure in China (season)
• Agro-meteorological condition assessment in China and in several main agricultural countries (monthly)
• Multiple-cropping index monitoring result in China (annually)
The main users of CropWatch are governmental organizations, such as State Council E-government, State Grain Administration, State Development and Reform Commission Ministry of Civil Affairs, National Disaster Reduction Centre of China and private-business clients, such as GrainWeb®.
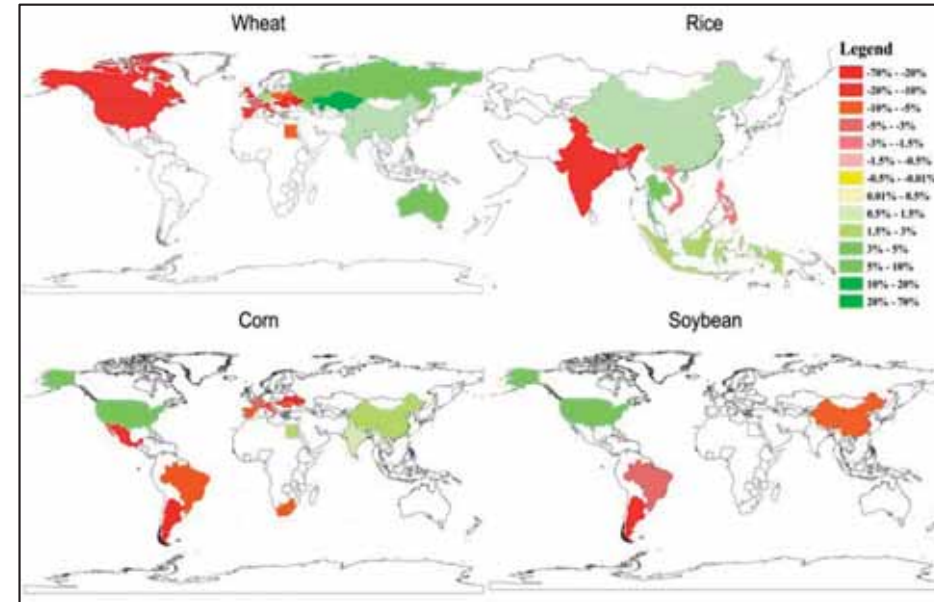
Monitoring result- Global grain supply situation in 2009

Partners:

• **National Grain and Oils Information Center, China**
• **Water Information Center, Ministry of Water Resources, China**
• **Disaster relief center of Ministry of Civil Affairs, China**
• **Institute of Geographic Sciences & Natural Resources Research, CAS**
• **Institute of Geodesy and Geophysics, CAS**
• **Cold & arid region environmental & engineering research institute, CAS**
• **Institute of Mountain Hazards And Environment, CAS**
• **Nanchang University, China**
• **Shandong Normal University, China**
• **Jiangxi Remote Sensing Information Center, China**
• **Shaanxi Remote Sensing Center, China**
• **Hubei Remote Sensing Center, China**

To know more?

• **Visit: CropWatch website**
http://www.cropwatch.com.cn/en/index.html
• **Contact: Dr Bingfang Wu, wubf@irsa.ac.cn**

4

FEWS NET is an activity of the USAID Office of Food for Peace (FFP). In 2008, FFP provided 2.6 million metric tons of emergency food aid worth over $2.6 billion to 56 million people in 49 countries on four continents. FEWS NET provides vital early identification of populations facing food insecurity, in support of FFP decision making. Subsistence crops and pastoralism characterize the livelihoods of the top twenty countries monitored, and they are typically water-limited agricultural systems. Consequently, FEWS NET agricultural monitoring is focused on early detection of food production anomalies due to drought.

FEWS NET partners, including USGS, NOAA, and NASA, have developed a custom monitoring capability that makes extensive use of remote sensing due to sparse station networks in the countries of concern.

Objectives: The primary objective of agricultural monitoring for FEWS NET is early identification of food production anomalies in regions of subsistence agriculture and pastoralism. These shocks are interpreted with of knowledge of livelihood systems and markets to assess their impacts on vulnerable populations, estimate the number of food insecure people, and project the period of need.

Data used: FEWS NET agricultural monitoring relies on a wide range of data types:
• Precipitation estimates from NOAA and NASA based on satellite observations, as well as station data from WMO and cooperating regional / national organizations.
• Vegetation index images from MODIS, AVHRR, and SPOT instruments.
• Atmospheric model fields from NOAA for temperature, radiation, and other variables.
• Images from Landsat, IKONOS, Quickbird, and Worldview for land cover/land use.
• Digital maps of administrative boundaries, soils, land cover; and digital elevation models.
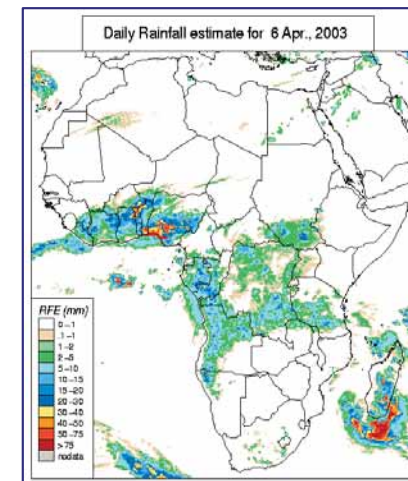• Field surveys of crop and rangeland conditions.
Future applications of soil moisture estimates from the NASA SMAP mission are planned.

Example of a daily grid rainfall estimate from NOAA based on a blend of satellite and station observations.

Procedures: Time series vegetation index images are used to assess the vigor and extent of crops in growing areas, and forage in rangelands. Within-season anomalies in greenness provide an early indication of potentially poor yields, production, and grazing.
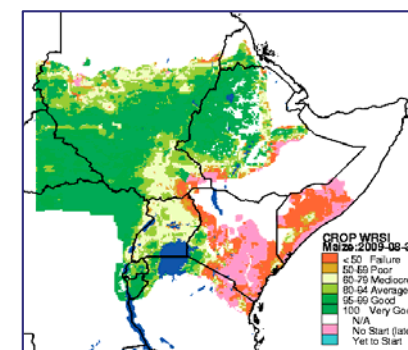
For situations where crop area is a significant unknown contributing to uncertainty of harvest outcome, FEWS NET has developed statistical methods based on interpretation of very high resolution imagery from IKONOS, Quickbird, and Worldview to make independent estimates.

Results:
• A wide variety of monitoring and modeling results in map form, available on the web
• Special reports and harvest assessments for priority countries of concern
• Weekly weather hazard assessments for Africa, Afghanistan, Haiti, and Central America
• Interpretation of climate forecasts for agricultural outcomes and development of food security outlooks
20 countries with resident FEWS NET representatives are currently monitored. Due to the global food crisis, more than 50 additional countries are being added in 2010 for remote monitoring (without in-country presence) .

WRSI results for maize on the Greater Horn of Africa, (Aug. 09). The extensive areas of crop failure due to drought are in Pink and red.

An example: Winter Wheat production in Afghanistan

The USGS, an implementing partner of FEWSNET, provides assessments of winter wheat production as an important input to food security decision-making for Afghanistan, where more than 70 percent of the country's wheat production is irrigated and relies heavily on spring snowmelt.

Remotely sensed data is utilized to identify how a given winter-wheat season ranks in terms of previous growing seasons. Furthermore, there is a need to assess whether irrigated and rainfed areas are equally impacted by water availability from snow melt and/or spring rainfall.

Data used: MODIS 250m Normalized Difference Vegetation Index (NDVI);
Food and Agriculture Organization (FAO), United Nations Development Programme (UNDP);
Afghan Geodesy and Cartography Head Office (AGCHO) 1993 Agricultural Lands Classification;
FAO / WFP Crop and Food Supply Assessment Mission (CFSAM) national yield estimates.

Procedures: The MODIS NDVI time series data are temporally smoothed to reduce cloud and other atmospheric effects on the vegetation signal. The smoothed data are delineated by irrigated and rainfed agriculture areas. The period of maximum NDVI, which shows strong correlation ($R2 > .90$) with CFSAM yield estimates, is spatially averaged for irrigated and rainfed areas at the province level. The results are ranked, by year, at the both the national and provincial levels.
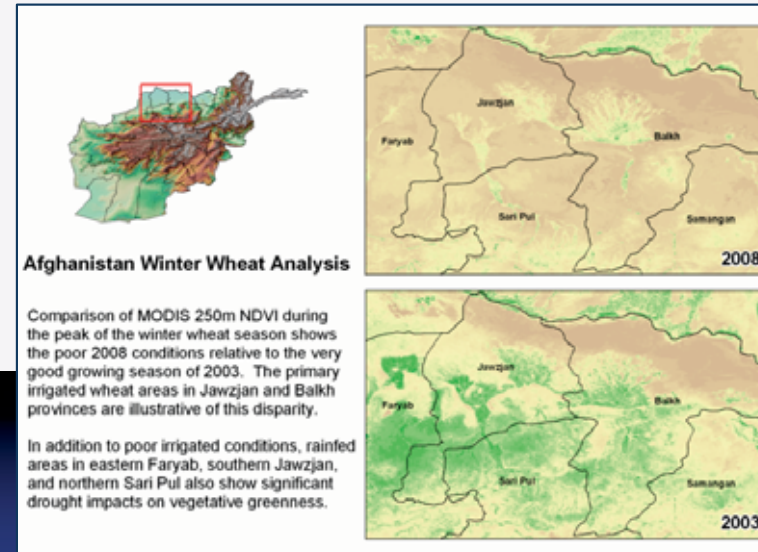
Results: The analysis of the irrigated winter wheat crop, for the period 2000-08, shows that 2008 ranks last at the national level, and last or second to last in 9 of the 11 most productive northern provinces. Similar results were found for rainfed areas at both the national and provincial level.

Afghanistan Winter Wheat Analysis

Comparison of MODIS 250m NDVI during the peak of the winter wheat season shows the poor 2008 conditions relative to the very good growing season of 2003. The primary irrigated wheat areas in Jawzjan and Balkh provinces are illustrative of this disparity.

In addition to poor irrigated conditions, rainfed areas in eastern Faryab, southern Jawzjan, and northern Sari Pul also show significant drought impacts on vegetative greenness.

MODIS NDVI imagery for the 2008 winter wheat season compared with the highly productive season of 2003 for a portion of northern Afghanistan.

Nationally, 2008 ranks as worst year since 2000

Irrigated Areas

Year	Maximum NDVI	Yield (t/ha)
2003	0.381	2.85
2007	0.373	2.69
2005	0.364	2.51
2006	0.357	2.58
2002	0.355	2.02
2004	0.335	1.93
2000	0.320	1.12
2001	0.317	1.31
2008	0.313	1.14*

* Estimated based on regression of maximum NDVI and historical yield figures

Partners:
- US. Ag. International Development (USAID) Office of Food for Peace
- U.S. Department of Agriculture - FAS IPAD
- NOAA Climate Prediction Center
- USGS Earth Resources Observation and Science Center
- Geography Department, University of California, Santa Barbara
- NASA Goddard Space Flight Center
- United Nations FAO and WFP
- SADC Regional Remote-Sensing Unit, Gaborone, AGRHYMET Regional Center, Niamey

To know more?

- Visit: FEWS NET website, http://www.fews.net
FEWS NET/USGS, http://earlywarning.usgs.gov
FEWS NET/NOAA, http://www.cpc.noaa.goc/products/fews/

- Contact:
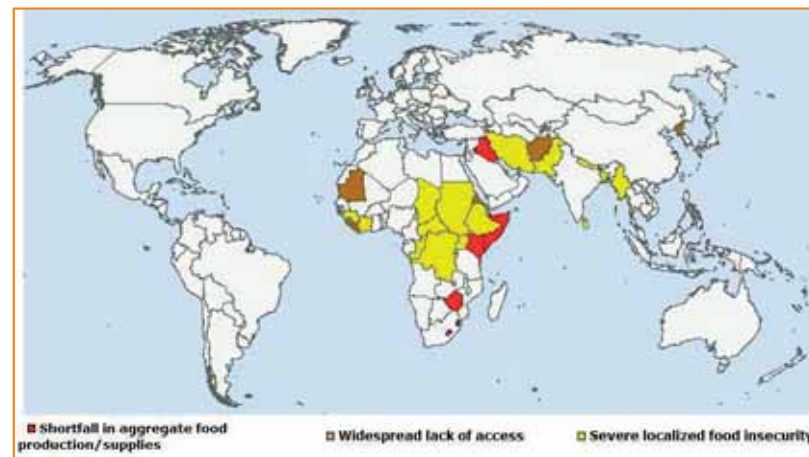James Verdin, verdin@usgs.gov
James Rowland, rowland@usgs.gov

In the past 35 years, GIEWS system has become a worldwide network which includes 115 governments, 61 Non-Governmental Organizations (NGOs) and numerous trade, research and media organizations. Over the years, a unique database on global, regional, national and sub-national food security has been maintained, refined, and accurate relevant crop information continuously updated.

Objectives:

• Monitoring regular food supply and demand in all countries of the world
• Compiling and analyzing information on global production, stocks, trade and food aid
• Monitoring export prices and developments on main grain exchanges
• Developing new approaches and technologies for early warning and makes these available to national and regional early warning systems
• Cultivating and maintaining a commitment to global food information-sharing between governments, NGOs, other UN agencies, research institutions, the international press and private individuals

Data used: GIEWS, in collaboration with FAO's Africa Real Time Environmental Monitoring Information System (ARTEMIS), receives data from the European METEOSAT satellite and established a crop monitoring system using near real-time satellite images. Data from four satellite systems are used for monitoring the various crop seasons around the world. Similarly, since 1998 the Japan Meteorological Agency has been providing FAO with 10-day estimated rainfall images for South-East Asia computed from data received from the Japanese GMS satellite. Most of these data are disseminated through (websites see for instance Climpag and GeoNetwork).

Procedures: GIEWS developed an integrated information system known as the "GIEWS Workstation" . The Workstation consists of customized tools that include country balance sheets, software for the display and analysis of maps and satellite images, and an electronic news service. The Workstation is linked to a unique reference database with pertinent information on food security at global, regional, national and sub-national levels. The GIEWS System collects information on possible "indicators" of food crisis such as local market food supplies, retail price rises and evidence of individual and community responses to food insecurity. Such responses are sometimes referred to as "coping strategies" and include unusual sales of livestock or other assets, migration in search of food, consumption of wild food which are not part of the normal diet and reduction in the number and size of meals. When it is available, data on malnutrition indicators and food related morbidity and mortality is also monitored.

□ Shortfall in aggregate food production/supplies □ Widespread lack of access □ Severe localized food insecurity

Countries in FS crisis requiring assistance (July 2009)

Example of the on-line data-base tool

To know more?
• **Visit: GIEWS website,**
http://www.fao.org/WAICENT/faoinfo/economic/giews/english/index.htm
• **The GeoNetwork data portal,**
http://www.fao.org/geonetwork/srv/en/main.home
• **Climpag website,** http://www.fao.org/nr/climpag/

• **Contact:** giews1@fao.org

Joint FAO-GIEWS/WFP Crop and Food Security Assessments

For countries facing a widespread and serious food emergency, FAO/GIEWS and WFP jointly carry out Crop and Food Security Assessment Missions (CFSAMs), at the request of national governments. The primary purpose of these Missions is to provide accurate, timely and credible information on imminent food security problems in a country or a region so that appropriate actions can be taken by the governments, the international community, and others, to minimize the impact of the food emergency on the affected populations. Main CFSAM objectives are:

• To make a rapid assessment of the status of major crops and prepare an estimate of food production for the current marketing year;
• Collect information on livestock production and health, and assess the contribution of livestock to food security;
• Use satellite imagery (provided through FAO/GIEWS) including Crop Yield Estimates (CYE), as an input into the selection of areas and specific sites to be visited;

• To assess the country's overall macroeconomic situation, its capacity to commercially import food and to effectively deal with the crisis.
• To evaluate the country's overall short-term food security by estimating total domestic availability of food supplies, total food utilization (human consumption, feed requirement, and industrial and other uses) and the resulting food deficit for the upcoming marketing year, to be met through estimated commercial imports, and food aid, if necessary.
• To assess the emergency food security situation including the number of people in need of emergency food assistance, their geographic distribution, and determine the volume and composition of food assistance requirements.
• To make a first assessment of potential for local purchases and constraints (rail and road transport capacity, etc.) to food assistance distribution.
• Occasionally, to contribute to a first assessment of short-term disruptions of the agricultural production capacity and immediate rehabilitation needs.

FAO/GIEWS National Basic Food Price Tool
   http://www.fao.org/giews/pricetool/

What's in the database?
A total of 845 commodity time series in 73 countries. (As of March 2010), including:
•   Staple food commodities (cereals, pulses, meat products)
•   Monthly retail, wholesale or export prices
•   Selection of markets per country

Supplementary info
•   Per caput consumption, % of DES, SSR of commodity
•   Data sources
•   Geographic location (on map), description of market (eg "Main market for wheat in north of country")

What else?
•   Nominal or real prices
•   Local measures or conversion to Kg or tonnes
•   Local currency or conversion to USD.

There is no single system of agricultural monitoring in Australia. The present page describes some main components (using remote sensing, models, agricultural statistics and environmental information) presently combined in different systems and tools, serving the needs of diverse audiences, ranging from government and industry planning to the management of climatic and market variability.

Examples of key agricultural monitoring systems :

• **"Yield Prophet"** uses an on-line crop production model designed to provide grain growers with real-time information about the crop during growth to fine-tune investment and input decisions.

• **"Pastures from Space"** provides estimates of pasture production during the growing season. Satellite data are used to accurately and quantitatively estimate Pasture Biomass or Feed On Offer (FOO); combined with climate and soil data, this is used to produce Pasture Growth Rate (PGR) estimates.

• **"AussieGRASS"** is a spatial model, developed in Queensland, now being developed at national level for grazing lands extension projects. It simulates pasture growth in climatic variability by integrating climate and natural resource data, remote sensing, historical agronomic research and simulation modelling.

• **"Australian Collaborative Land Use Mapping Programme"** is a consortium of Australian and State Government partners, using earth observations data to produce a consistent land use mapping coverage at both 'continental' and 'catchment' scale and developing land management practice mapping / monitoring.

• **"Agri-environmental monitoring – LANDMONITOR"** is a coordinated initiative supported by the CSIRO and WA agencies to systematically monitor salt-affected land and remnant vegetation change over the agricultural area of south west of Western Australia.

• **"Australian Climate and Agriculture Update"** is a monthly national overview for primary producers and agricultural policy; It covers rainfall and temperature conditions, water storage levels and water allocation announcements, crop and livestock production and the climate outlook.

Independently of these monitoring systems, **"Agricultural production statistics"** are produced through censuses and surveys , collecting data on crops' area & production, livestock numbers & products and land management (see http://www.abs.gov.au/) ; The annual **"Australian farm surveys and agricultural productivity"** capture current and historical economic performance of farm business with detailed financial, physical and socioeconomic information, focusing on the broad acre and dairy sectors –- see http://www.abare.gov.au/
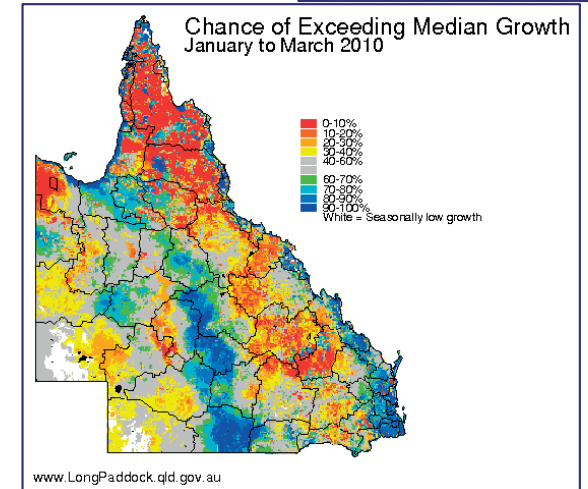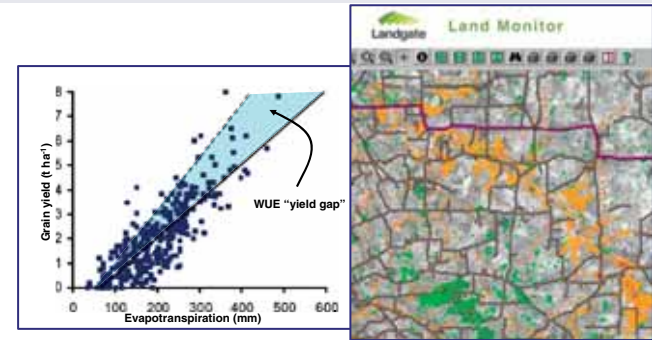
Examples of outputs from Yield prophet (top left), LANDMONITOR (top right) and Aussie GRASS (above)

To know more?

• **Visit the web sites:** "Yield Prophet": http://www.yieldprophet.com.au,

"Pastures from Space", www.pasturesfromspace.csiro.au

"LANDMONITOR", http://www.landmonitor.wa.gov.au/

"Collaborative Land Use Mapping Programme", http://adl.brs.gov.au/mapserv/landuse/

"AussieGRASS", http://www.longpaddock.qld.gov.au/AboutUs/ResearchProjects/AussieGRASS/Project/

"Climate and Agriculture Update", http://www.daff.gov.au/brs/climate-impact/climate-agricultural-update

• **Contact:** Mike Grundy (CSIRO), Mike.Grundy@csiro.au

16

Partners :

• **Agriculture and Natural Resources Management Agencies of Australian and State Governments**

• **Bureau of Rural Sciences**

• **Geoscience Australia**

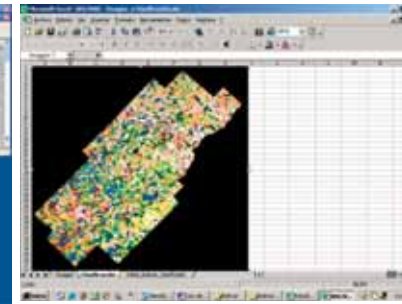• **CSIRO (Commonwealth Scientific & Industrial Research Organization)**

Within the Ministry of Agriculture, Livestock and Fisheries (MinAgri), the Dirección de Coordinación de Delegaciones (DCD) is the national Argentine government agency responsible for agricultural estimates.

Objectives: This mission is accomplished by a network of 34 offices throughout the main agricultural areas, gathering information about different items concerning agriculture including: area, yield, seeding and harvesting progress, crop condition, etc. Each of these offices reports periodically to the DCD in Buenos Aires, where the information is checked, summarized and released to the user community.

Data used: Traditionally, subjective estimates were used. Since 1981 however, remote sensing technology is applied to improve the area estimations through 4 approaches:

• Land use/land cover stratification as a basis for area sampling frames. The primary stratification inputs have been Landsat imagery, vector-data for roads and rivers, soils information, rainfall information and most importantly digital cadastral data. The work is done at the *departamento* level (department /county).

• Digital analysis using classification techniques of satellite imagery (Landsat) to estimate planted areas of the extensive major crops: Wheat, Corn, Soybean.

• Support to local offices in estimate procedure: Medium resolution imagery (SAC-C, 175 m pixel size) and e-mailing of results (Excel table).
• Area assessment of non-extensive crops (Potatoes in the SE province of Buenos Aires province).

It is worthwhile mentioning that all the satellite imagery used, is provided freely by the National Commission of Spatial Activities (CONAE).

MinAgri is currently developing a statistical sampling survey program. The goal is to develop a sampling design based on a stratified area frame which is flexible enough to meet sampling needs and that can be ready to use promptly. Digital area frames are ready for Buenos Aires and La Pampa provinces; the Santa Fe area frame is under development and work on the Cordoba and Entre Rios frames is scheduled to begin in 2010.

Partners:
• **Comision Nacional de Actividades Espaciales (CONAE) - www.conae.gov.ar**
• **Instituto Nacional de Tecnologia Agropecuaria (INTA) - http://geointa.inta.gov.ar**
• **Servicio Nacional de Sanidad Agraria (SENASA) - www.senasa.gov.ar**

To know more?

• **Visit: MinAgri website, www.minagri.gob.ar**
• **Contact: Ing. Juan Usandivaras, juan.usandivaras@prosap.gov.ar**

The "Geosafras Project" of CONAB (Brazil´s National Food Supply Company of the Ministry of Agriculture) is responsible for generating and analysing data for agricultural monitoring, area estimates and yield forecasting. CONAB/Geosafras has partnered with several institutions (universities, research institutes, meteorological institutes/services) for data collection and cropland masking.

Objectives: Mapping and monitoring agricultural areas and build a historical database (imagery + meteorological data) for use in yield estimation models, in order to generate more consistent agricultural statistics.

Data used: Cropland masks are generated from 1km Spot vegetation and 250m MODIS data, covering the whole country. For coffee and citrus areas, 30m Landsat and 10m SPOT imagery are being used.

Procedures: The cropland masks are based on NDVI differences for the summer and winter cropping seasons. Coffee and citrus areas are mapped based on visual interpretation and digital classification. In both cases ground reference data are collected for accuracy assessment.

Results: A general map of sugarcane and annual crop masks was generated for the country, which will be updated every year, given the dynamics of Brazilian agriculture. Bio-fuel production plants are also located in order to monitor land use change around those areas. Perennial crops Maps (such as coffee and citrus) will be updated every 4-5 years.
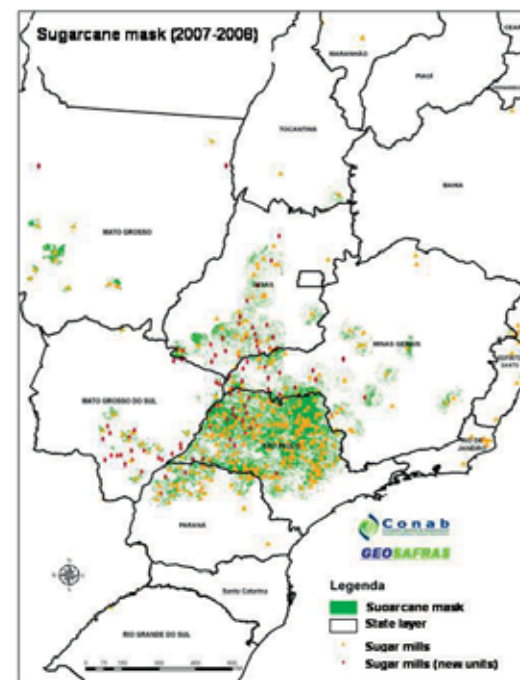
Partners:
- CONAB (Companhia Nacional de Abastecimento), coordinator and beneficiary)
- INMET (Instituto Nacional de Meteorologia)
- UNICAMP (Universidade Estadual de Campinas)
- UFRGS (Universidade Federal do Rio Grande do Sul)
- IAC (Instituto Agronômico de Campinas)
- SIMEPAR (Instituto Tecnológico do Paraná)
- INPE (Instituto de Pesquisas Espaciais)
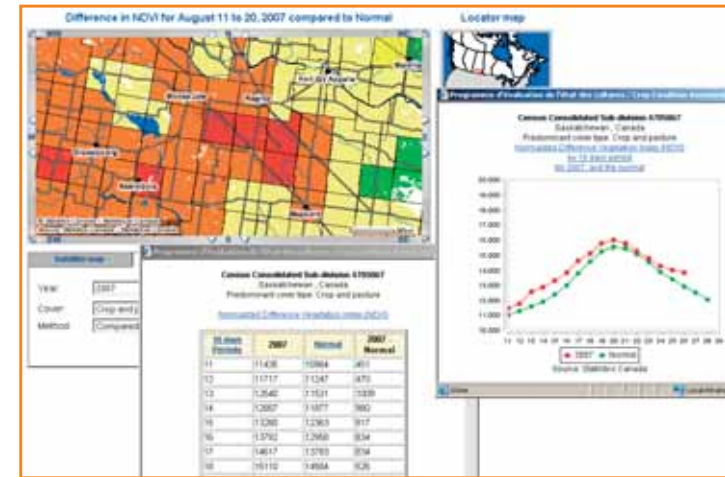- EMBRAPA (Empresa Brasileira de Agropecuária)

To know more?
- **Visit: CONAB website,** http://www.conab.gov.br/conabweb/index.php?PAG=81
- **Contact:**
Jansle Rocha , jansle.rocha@feagri.unicamp.br (about GEOSS)
Silvio Porto (CONAB, Director), silvio.porto@conab.gov.br
Társis Piffer (CONAB, Geotechnologies), tarsis.piffer@conab.gov.br
André Farias de Souza (CONAB, Geosafras technical), andre.souza@bra03034.conab.gov.br

Canada's Crop Condition Assessment Program (CCAP) is developed and maintained by Statistics Canada, supported by Agriculture and Agri-Food Canada and is delivered to the public free of charge through Statistics Canada's website. Crop condition monitoring contributes to policy outcomes by supporting water resources management, reducing vulnerability to risk, and supporting production risk programs. It is a particularly important contributor to several agri-environmental information and application needs, especially monitoring of drought and other risks to sustainability.

Objectives: Providing access to information on current and past cropland and pasture vegetation conditions

Data used: Statistics Canada currently uses Advanced Very High Resolution Radiometer (AVHRR from NOAA)-derived 1km-resolution Normalized Difference Vegetation Index (NDVI) data for crop assessment on the prairies (weekly composites) and across the country (10-day composites). Value added data sets are produced from NDVI composites by relating current crop condition to historical normal and yield forecasting. This application started in 1989 and became available as an internet application in 2000.

Procedures: AAFC has contributed to this system through processing 250m-resolution NDVI data for both weekly composites and multiple time-period composites for all of Canada from Moderate Resolution Imaging Spectroradiometer (MODIS from NASA). AAFC has developed an operational system that can create weekly NDVI datasets. The system became operational during the 2009 growing season. The MODIS NDVI composites are currently being integrated into the Statistics Canada CCAP website.

Crop Condition Assessment Program

Partners:
• Agriculture and Agri-Food Canada (AAFC)
• NASA, Goddard Space Centre

To know more?
• Visit: CCAP website, http://www26.statcan.ca/ccap/start-debut-eng.jsp
AAFC / CCAP website, http://www.agr.gc.ca/pfra/drought/ccap_e.htm
• Contact:
AAFC, ian.jarvis@agr.gc.ca
Statistics Canada, Gordon.Reichert@statcan.gc.ca

Weekly Crop Condition Imagery from MODIS

The China Agriculture Remote Sensing Monitoring System (CHARMS), was initiated in 1998 and was put into operation in 1999. This system carries out monitoring for key crops and grasslands, including acreage change, crop growth and development, yield & productivity, disasters and grassland degradation. The monitoring activities are coordinated by Remote Sensing Application Center of MoA (RSAC, Ministry of Agriculture) and provide monitoring information during the crop growing season to the MoA and related agriculture management sectors.

Objectives: CHARMS main task is monitoring of crop acreage change, crop growth and drought dynamic across the agricultural regions of China. It carries out field surveys with systematically-distributed sample plots and provides yield predictions and production estimates for China.

Methodology: The system consists of 4 parts:

• Database;
• Crop acreage change monitoring module using remote sensing;
• Crop yield estimation module;
• Scaling-up module.

The yield estimation module includes crop growth monitoring and drought monitoring sub-models.
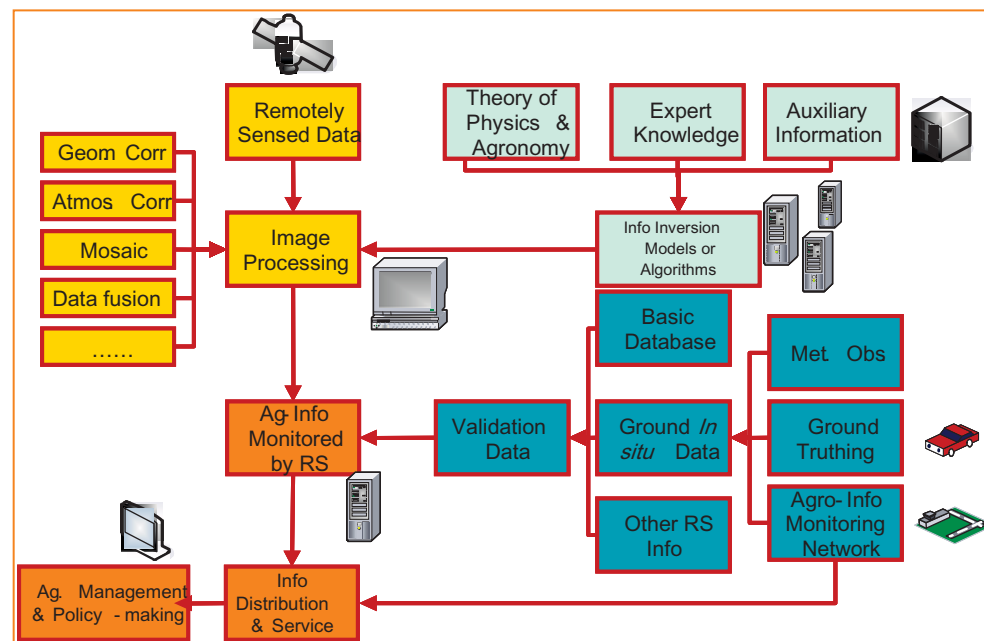
Remote sensing data are pre-processed in the Research and Application Department of RSAC (Beijing) and distributed to the 11 regional centers in charge of specific crop monitoring , imagery interpretation and ground-validation. Regional results are submitted to the Beijing Headquarter for integration.

An important in-situ information collection network is administrated by MoA and provides data used by CHARMS for calibration/validation of crop growth as well as soil moisture monitoring by remote-sensing.

Results: Currently, the CHARMS system monitors wheat, corn, rice, soybean and cotton monitoring.

Logic of the CHARMS crop monitoring system

Partners:
• **Remote Sensing Application Center of MoA (RSAC)**
• **Institute of Agricultural Resources & Regional Planning**
• **Chinese Academy of Agricultural Engineering,**
• **11 regional Centers of RSAC – Ministry of Agriculture**

Independently of CHARMS, **the National Meteorological Centre** *of the China Meteorological Administration provides agro-meteorological Information services in China, based mainly on in-situ agro-meteorological data. This includes: agro-meteorological information; monitoring of soil moisture, agricultural drought, agro-meteorological disaster; crop yield forecasting. Main Tools include statistical model, remote sensing yield estimating model and dynamic crop growth model.*

To know more?

• **Visit: CAAS website, http://www.caas.net.cn/engforcaas/index.htm**
• **CHARMS: Contact Dr. Chen Zhongxin, zxchen@mail.caas.net.cn**
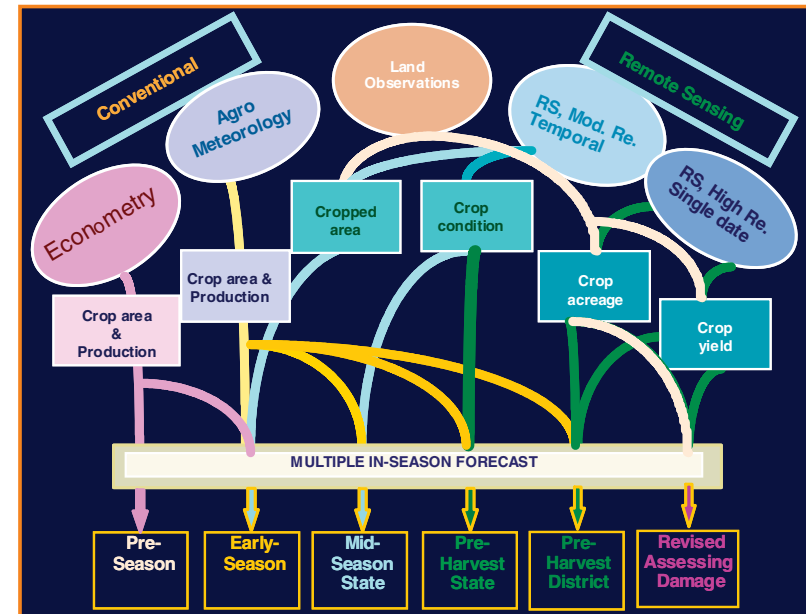• **National Meteo Centre: Contact Dr Hou Yinyu, yyhou@cma.gov.cn**

Space Applications Centre (SAC) of Indian Space Research Organization (ISRO) at the behest of Dept. of Agriculture & Cooperation, Govt. of India has developed the concept of Forecasting Agricultural output using Space, Agro-meteorology and Land based observations (FASAL)

Objective: Multiple in-season assessment of crops, acreage estimation and production forecasting at national level primarily using remote sensing data.

Data used: Multi-source data, such as optical remote sensing (IRS AWiFS and LISS-III) microwave (Radarsat-SAR), weather data from network of Automatic Weather Stations (AWS) and other ground stations along with rainfall estimates from space observations like INSAT-VHRR and NOAA-CPC are being used.

Methodology: Temporal RS data are registered and decision rule based classification is performed to estimate the crop acreage. Multi-stage sampling is used covering major crop growing regions in the country for selection of segments from RS data for crop assessment. Spectral indices and weather data based yield models are used for crop yield forecasting.

Results: Multiple in-season acreage estimates and production forecast are made for crops like rice, wheat, potato, rapeseed/mustard and jute at national level with state level details. District level production forecasts are made for cotton, wheat, rapeseed/mustard, sorghum and sugarcane crops. Significant year-to-year changes are shown using the images of corresponding seasons. Map of damage due to episodic events are provided.
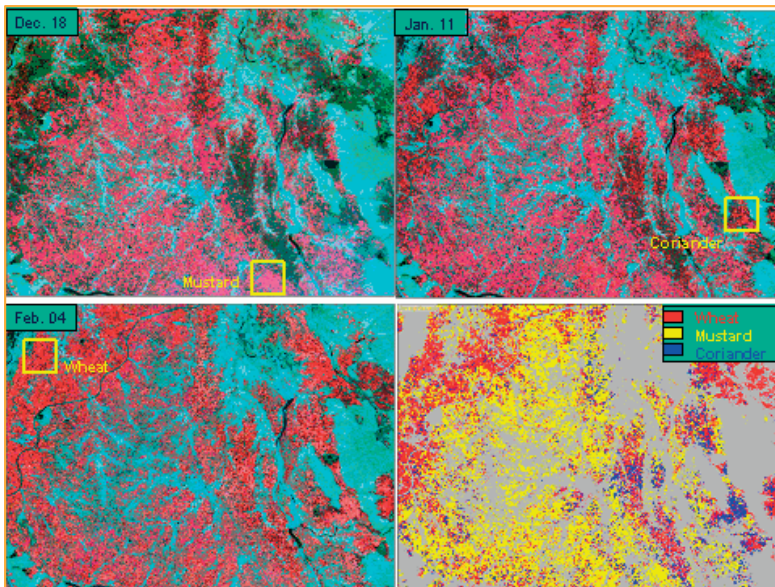

The FASAL concept

Result from crop acreage estimation

Partners:
- **Space Applications Centre (ISRO), Ahmedabad**
- **Dept. of Agriculture & Cooperation, Govt. of India, New Delhi**
- **State's Remote Sensing Centre & IES&WM, Kolkata**
- **CPRI, Shimla & DRMR, Bharatpur (ICAR)**
- **National Remote Sensing Centre, Hyderabad**
- **State's Agricultural Universities and Agriculture Dept.**

To know more?

- **Visit: http://www.isro.org/scripts/rsa_fasal.aspx**

- **Contact: Space Applications Centre, jsparihar@sac.isro.gov.in**
  Dept. of Agri. & Cooperation, Govt. of India, ncfc@nic.in

21

The National Centre of Space Research and Technologies (NCSRT) of the National Space Agency of Kazakhstan operates a satellite-based crop monitoring system for the Agriculture Ministry. The activities of the NCRST in this field includes the following tasks:
- Estimation of spring soil water content,
- Spring crop acreage estimation,
- Cereals sowing date control,
- Spectral empirical models for crop state assessment and grain production forecasting.

Objectives: In Kazakhstan spring wheat and barley are regional monocultures and cover more than 100,000 km2 of cropland . The very large field size (400ha) allows for effective daily monitoring using coarse resolution data from MODIS.   In the framework of the operational monitoring system, multiple assessments of the cereal areas (80% of total croplands) are carried out over the growing season.

Data used: The operational agricultural monitoring system is based on the use of:
• Multi-resolution optical satellite data: NOAA/AVHRR (1100 m), EOS MODIS (250 m) , IRS AWiFS (56m) +LISS – III (23 m)
• Weather data from the network of Kazakh ground stations and own fields inspections.

Procedure and results: Empirical relationships between spectral indices and ground data are used as the basis for the operational crop assessment. Crop acreage estimation includes the two different stages:
(i)   estimation of field size using satellite data (RMSE < 5%, ρ= 0.98);
(ii) land-use mapping according to two classes: annual spring crops and other crops (RMSE ~ 1%).
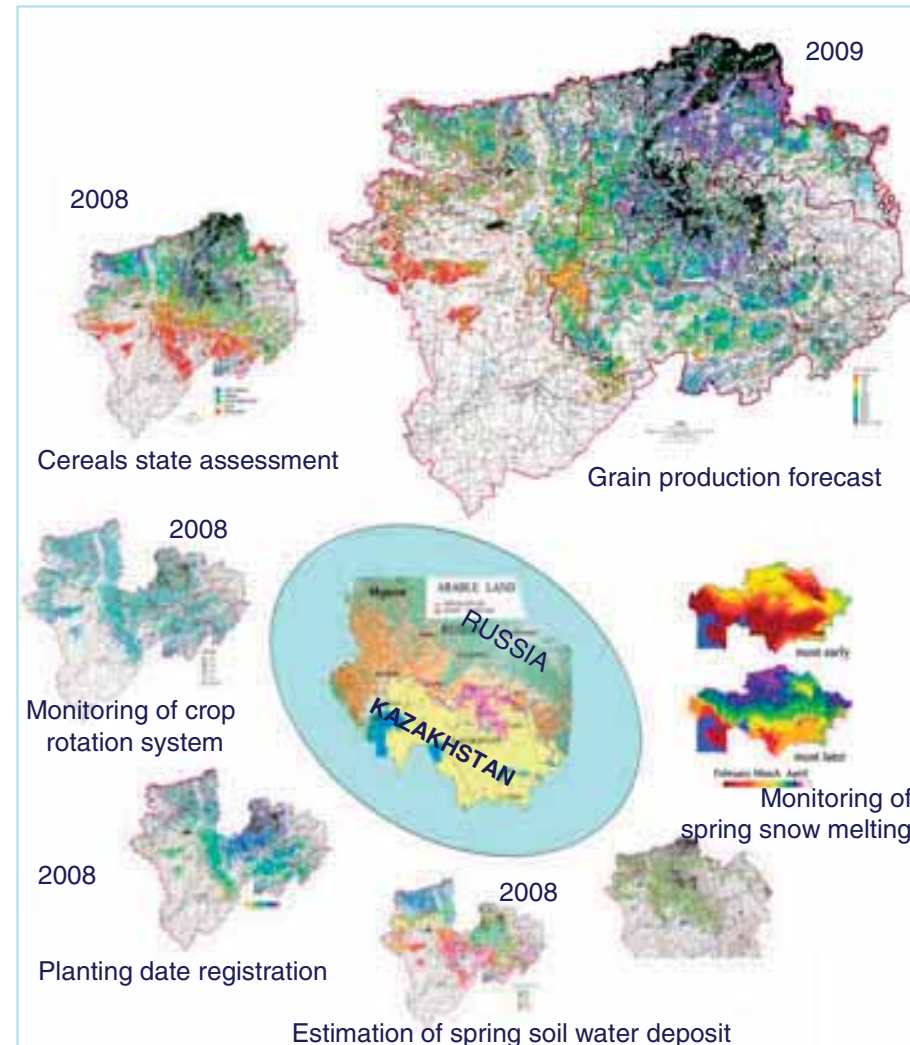The province level production is assessed twice per year, one month before harvesting and after harvesting.

Partners:
• Departments of agriculture and phytosanitary security of the Ministry of Agriculture
• Kazakhstan's State Agency of Land Management
• Agriculture scientific Centers of the Ministry of Agriculture

To know more ?

• Visit: http://izk.gzi.kz
• Contact: Lev Spivak, levspivak@mail.ru
Alexey Terekhov, aterekhov1@yandex.ru
Nadiya Muratova, nmuratova@mail.ru

2009

2008

Cereals state assessment

Grain production forecast

2008

RUSSIA

KAZAKHSTAN

Monitoring of crop rotation system

Monitoring of spring snow melting

2008

Planting date registration

2008

Estimation of spring soil water deposit

22

The South African National Department of Agriculture, Forestry and Fisheries (DAFF) is the custodian of the Crop Estimates Committee (CEC) that is responsible for grain crop production estimates. Grain crops in South Africa consist of two groups: maize, sunflower, soya beans, dry beans, groundnuts and sorghum which are cultivated during the summer; the second crop group is grown during the winter and includes wheat, barley, oats and canola.

Objectives: To estimate planted areas and forecast yields based on a geographic point sampling frame that is stratified according to cultivation density, while also continuously improving the system developed by the National Crop Statistics Consortium (NCSC).

Data used: Satellite imagery (Landsat 5 as well as Spot 2 and 4) over three seasons was used to capture field boundaries for all potential cultivated fields in the country. The systematic geographic random samples were surveyed to determine the crop type for each field/point by aerial observations using Very Light Aircraft (VLA).

Procedures: Satellite imagery was used as a first step to stratify the country by separating all non-agricultural areas from agricultural areas. A point grid with 225 m intervals, generated across the cultivation intensity strata, was used for a systematic geographic random selection of points, with an increased sampling rate in higher density cultivation areas. Subsequently, the methodology has been expanded and implemented on an operational level, providing reliable crop area estimates for the eight major summer grain producing provinces: North West, Mpumalanga, Free State, Limpopo, KwaZulu-Natal, Northern Cape, Eastern Cape and Gauteng.
Information gathered during the aerial survey was firstly used to calculate statistical area estimates for each crop type per province. Secondly it was used as training sets for classification of satellite imagery, to generate a crop type for each individual field. Considering the phenological stages for each crop type, crops such as sunflower and maize had substantial overlap in the signature files, and maize was split into six classes of more specific spectral types. Yield is obtained by field measurement at a subset of the randomly selected points.
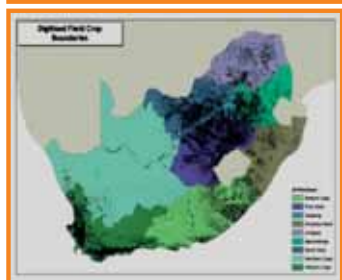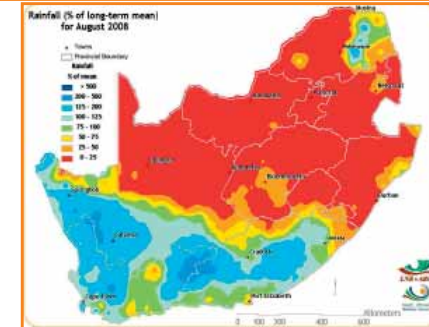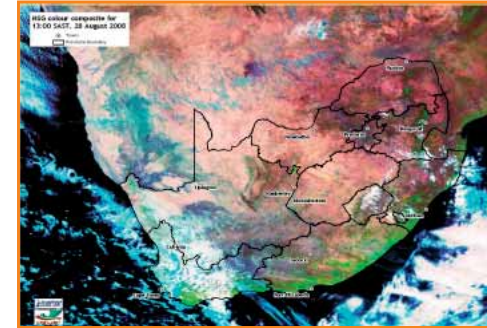
Results: Images were classified using the ERDAS supervised classification approach by selecting the maximum likelihood combined with the parallel-piped functions. After the supervised classification procedure, a zonal majority function was used to assign a crop type to each field boundary polygon based on the raster classification. This step generated an ESRI shape file with a crop type for each field during a specific season for an entire province, providing a basis for various queries and analysis. Through integrating and combining technology it was possible to calculate statistical area estimates for each province through aerial surveys, while also generating a map showing the spatial distribution of crop type patterns. It is now possible to extract information on sub-provincial level such as agro-climatic zones or district level, or any polygon boundary of importance.

Partners:
• **Agricultural Research Council (ARC), South Africa**
• **GeoTerraImage (GTI), South Africa**
• **Spatialintelligence (SiQ), South Africa**

To know more ?

• **Visit: National Department od Agriculture, Forestry & Fisheries website, www.daff.gov.za**

• **Contact:**
Terry Newby, Terry@arc.agric.za
Eugene du Preez, Eugene.duPreez@siq.co.za

The Space Research Institute of Russian Academy of Sciences (IKI) has led the project of Russian Ministry of Agriculture in developing the state agricultural monitoring system based on remote sensing data aimed at monitoring of agricultural lands status, crop acreage estimation at district level, yield forecasting, and assessment of crop damage due to unfavorable natural conditions.

Objectives: In-season, multiple assessment of crops at federal, regional (oblast), district levels and production forecasting.

Procedures: The monitoring system is based on the use of multi-source data, such as regional agricultural committees, satellite remote sensing data (mainly MODIS) and ground agro-meteorological observations.
A special software chain has been developed for raw MODIS data pre-processing. Crop and arable lands acreage assessment is performed on the basis of NDVI and PVI time-profile analysis.
MODIS derived vegetation indices and weather data are used for crop yield prediction, based on regression model and similarity analysis (identification of analogue years).

Results: Yearly assessment of acreage of arable lands, winter, summer crops and fallow lands at country and province (oblast) level. Yield prediction for main crops at province (oblast) level, starting from the beginning of growing season up to the end of the season with weekly prediction updating.
Ad-hoc analysis of impact of drought and spring frosts.
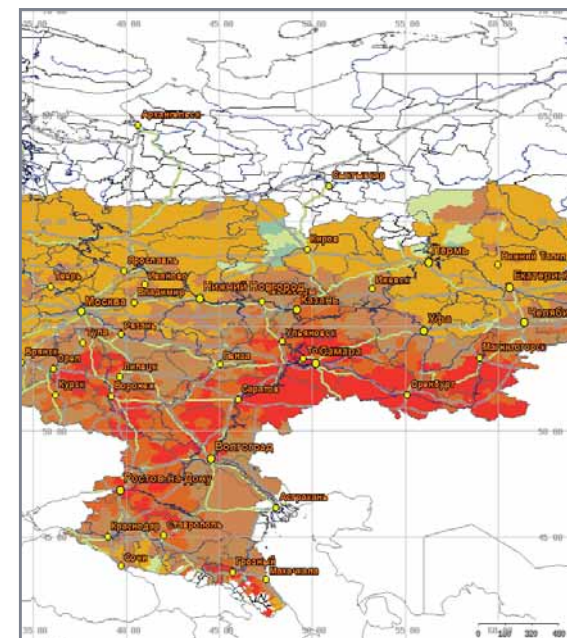
Impact assessment of 2009 drought in Southern Russia
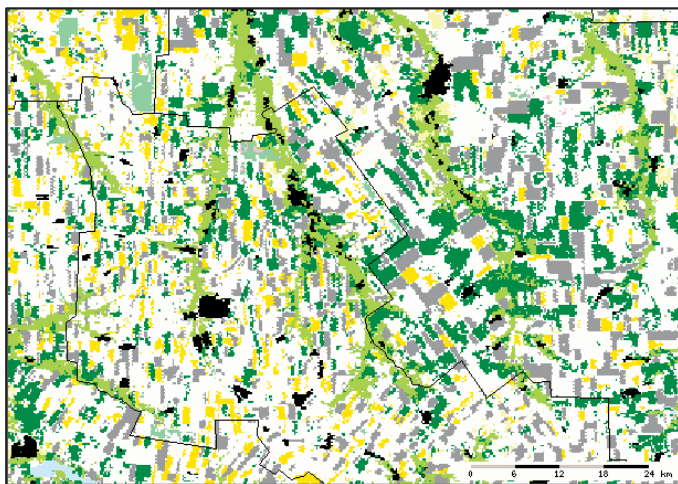
Result from crop recognition based on MODIS (different colors indicate different crops)

Partners:
• **Main Computation Centre of the Ministry of Agriculture of Russia**
• **Province's Remote Sensing Centers (St. Petersburg, Obninsk)**
• **State Universities (Moscow, Krasnoyarsk, Samara)**

To know more ?

• Visit: http://www.agrocosmos.gvc.ru/
• Contact: Eugeny LOUPIAN, evgeny@d902.iki.rssi.ru

24

U.S. Department of Agriculture/National Agricultural Statistics Service (NASS) produces in-season remote sensing based acreage estimates for major crops in 27 states. NASS relies on partnerships with many institutions to produce the crop specific supervised land cover classification called the Cropland Data Layer (CDL) and serve to the public domain. The CDL is produced annually providing independent acreage updates for Agency decision support.

Objectives: To produce remote sensing based timely, accurate, and unbiased in-season state/district/county level acreage estimates for decision support. Release to public a crop specific land cover classification called the Cropland Data Layer (CDL).

Data used: Resourcesat-1 AWiFS (56m) and Landsat TM (30 m) are collected year round, cloud free over large areas. The Farm Service Agency/ Common Land Unit (CLU) serves as extensive agricultural specific ground truth (i.e., training/testing) data. NASS June Agricultural Survey (JAS) a probability based survey is used for regression modeling. MRLC/National Land Cover Dataset (NLCD) circa 2001 utilized for non-agricultural ground truth. Additionally, the National Elevation, NLCD Forest Canopy, and Imperviousness datasets are input as ancillary datasets into the classification.

Procedures: The AWiFS and Landsat imagery are screened for clouds and selected for use, re-projected then mosaicked and stacked in preparation for processing. The CLU ground data is checked for consistency, cleaned and joined with attribute administrative data, then sampled in preparation for testing.
The NLCD dataset is also sampled over the non-agricultural domain. The samples are data-mined using boosted classification tree analysis to derive best fitting decision rules, then the derived decision rules are applied back to data stack, to create the land cover and probability map classification.
The classified image called the CDL is then regressed against the NASS/JAS ground truth to develop independent acreage estimates. The CDL is then prepared for public distribution.

Results: In-season acreage estimates delivered for 27 states for crop year 2009 for Agency decision support, while 48 total states were delivered to as 2009's Cropland Data Layer geospatial data products, is publically available online at the USDA National Resource Conservation Service's Geospatial Data Gateway.

Cropland Data Layers 2008 States
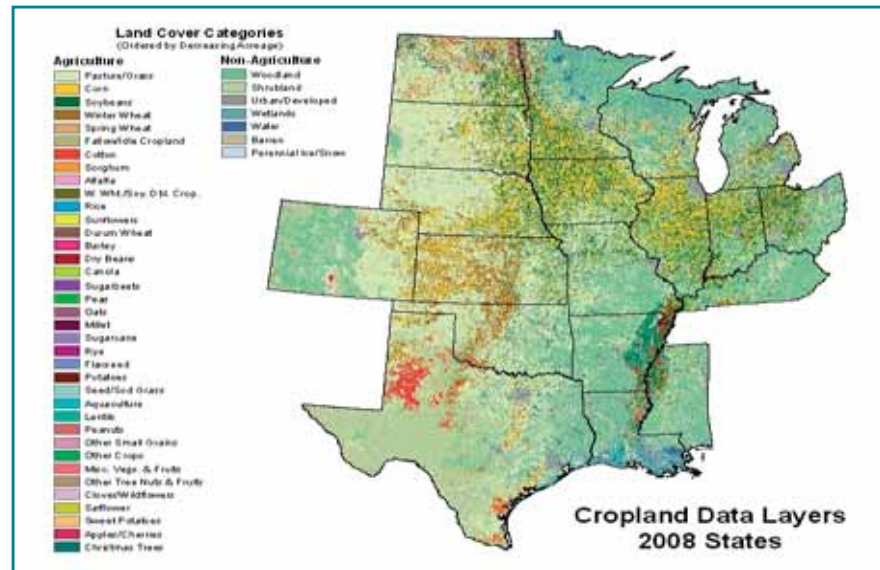
Partners:
• USDA /Foreign Agriculture Service/ International Production Assessments Division (IPAD)
• USDA /Farm Service Agency / Common Land Unit
• USDA /National Resources Service/ Geospatial Data Gateway
• U.S.G.S/ Multi-Resolution Land Characteristics Consortium
• US Environmental Protection Agency

To know more ?

• Visit the NAAS CDL web page: http://www.nass.usda.gov/research/Cropland/SARS1a.htm

USDA data Gateway: http://datagateway.nrcs.usda.gov/

• Contact: rick_mueller@nass.usda.gov

25

Observation Requirements …

From Observations to Information

The two components of crop monitoring (area estimates and yield forecasts) benefit from the full range of earth observation systems, as summarized by the following diagram, which provides an overview of the links between the remote sensing data and the final crop monitoring products.
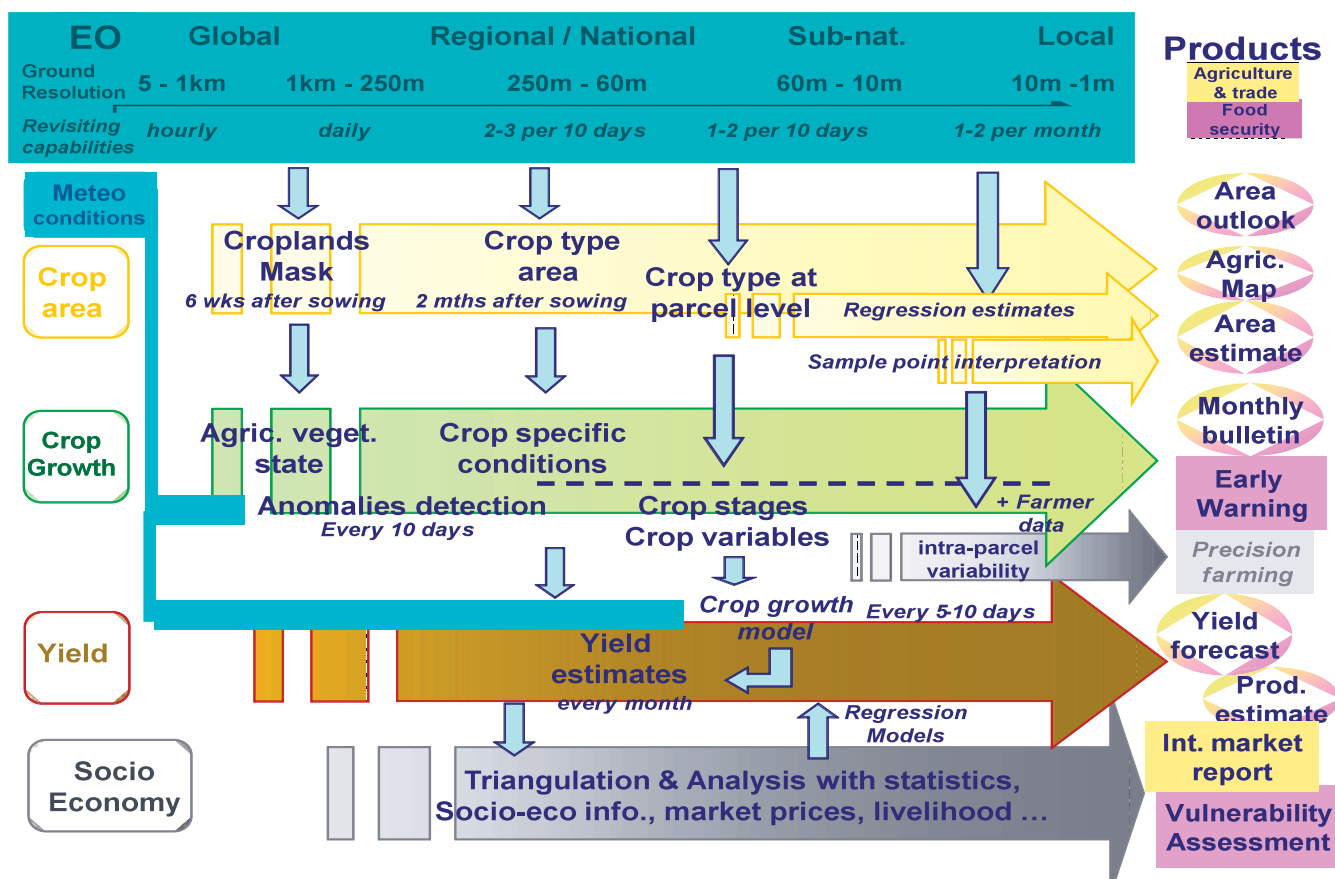
Adapted from Pierre Defourny, UCL -07

Satellite Observation Requirements

- Global coverage of coarse resolution geostationary meteorological satellite data (5 km -1 km) are needed to provide hourly monitoring of weather conditions and rainfall.
- Daily, global coverage of coarse resolution polar orbiting data (1 km - 250 m) are needed to provide a cropland mask and to monitor vegetation state and identify anomalies.
- At the national and sub-national scale, 2-3 coarse to moderate resolution data (250 - 20 m data) are needed every ten days to map crop type area and to detect crop specific conditions and anomalies.

... and the System of Systems

- One to two images of high resolution data (20 - 5 m) are needed every ten days to provide information on crop type, crop development stage and other crop variables at the parcel level.
- One to two fine resolution observations (5 - 1 m) per month or season are needed to provide sample point interpretation and sub-parcel variability which can feed a crop growth model used in yield estimation.

The Global Agricultural Monitoring System of Systems

will integrate data from multiple satellite assets which provide information at a wide range of spatial and temporal resolutions for monitoring rainfall, reservoir heights, crop type and acreage, crop condition, yield and production, cropping systems and land use change. In-situ observations will be needed primarily from meteorological stations and field surveys. This monitoring system of systems will deliver reliable, timely and continuous data. Regional scale models will provide seasonal forecasts, and crop models will be used by international or national agencies to assimilate these data to provide harvest forecasts during the growing seasons, identify harvest shortfalls and estimate yield and production. Global climate and integrated assessment models will generate estimates of future distribution of agriculture for prospective analysis of supply/demand of agricultural commodities.

Enabling Conditions

Several of the necessary components for a comprehensive agriculture monitoring system are in place but are not integrated into a system of systems. A number of enabling conditions have been identified in order to implement this GEO system of systems. The foremost is increased level of cooperation amongst the GEO partners including national governments, the space agencies, commercial data providers and weather services to establish non-prohibitive data pricing polices that allow for free and open sharing of data, enabling affordable agricultural monitoring.

Rather than design and build a new system, the Community of Practice is utilizing the current available assets and is working together to enhance the system components necessary for a comprehensive agricultural monitoring system of systems.

- *Near real-time satellite data are needed, with increased frequency of coverage*
- *Greater coordination is needed amongst the Space Agencies, particularly with respect to Landsat-class resolution data acquisition, data continuity, data formats and interoperability*
- *System enhancements are needed in terms of frequency of optical and microwave coverage*
- *In-situ observations are needed (phenology, farming practices) and the network of meteorological stations needs to be reinforced, particularly in food insecure parts of Africa*
- *International standards are needed for data collection and reporting, and best practices need to be established by the Community of Practice.*

2015 targets and main activities

2015 targets for GEO Agriculture

As part of the GEO Secretariat coordination, a set of 2015 targets has been developed for each GEO societal benefit area. The targets for the GEO Agriculture Monitoring task aim to:

> *" Improve Earth observations and their utilization in agriculture to enhance monitoring and management of sustainable agriculture, providing timely and operational information on crop production, famine early warning, food security, and risk assessment, and building capacity in developing countries."*

This will be demonstrated by:

- Improved agricultural risk assessment and operational weather/climate forecast systems for food security;
- Effective early warning of famine enabling a timely mobilization on an international response in food aid;
- Increased use of Earth observing capabilities to support timely, objective, accurate and transparent agricultural statistics and information at the national level;
- Improved monitoring of agricultural land use change, through periodic global assessments;
- Improved collaboration and coordination on the use and applications of Earth observations for fisheries, aquaculture, forestry and land cover mapping.

This will be achieved through:

- A set of distributed joint experiments to compare and evaluate data and methods;
- A series of thematic workshops for the community of practice and capacity building;
- Establishing the regional components of an agricultural monitoring system of systems;
- Developing and adopting standards and common reporting formats;
- Advancing free and open data policies, data sharing and advocating for data continuity, expanded coverage and coordinated data acquisition;
- Collaborating and coordinating with the forest /land cover mapping communities and consultation with experts from fisheries / aquaculture, coastal zone management and Earth observation communities.

… and near term activities

The GEO Global Agricultural Monitoring Community of Practice (CoP) recognizes that in order to build such system of systems it is necessary to start with a set of near term tasks that are feasible and realistic.

These activities are currently grouped under four main sub-tasks:

- **A multi-source Production, Acreage and Yield (PAY) database** on a common platform. This will facilitate inter-comparison of yield and production statistics generated by different global and national reporting systems;

- **Joint experiments on Crop Assessment and Monitoring (JECAM)** undertaking data, modeling and monitoring inter-comparisons, accuracy assessments and integration, based on multi-source satellite and in-situ data – prototyping system of systems;

PAY prototype under validation (2009)

- **Coordinated Data Initiatives for Global Agricultural Monitoring (CDIGAM).** To ensure the on-going, frequent and timely acquisition accessibility of satellite data during agricultural growing season and the continuity of those observations necessary for agricultural monitoring;

- **GLAMMS Thematic Workshop Series (GTWS).** Community workshops to improve communication among the CoP on priority topics, develop best practices and standards and encourage international cooperation, coordination and data sharing.

GEO Agricultural Monitoring Partnership

In addition to close cooperation amongst the Community of Practice, a number of additional partnerships are crucial for implementing the GEO Agricultural Monitoring sub task.
These partnerships are being facilitated by the GEO Secretariat.

CEOS and the Land Surface Imaging (LSI) Constellation

The Committee on Earth Observation Satellites (CEOS) is the satellite arm of GEO. The help of CEOS is needed for international coordination amongst the space agencies, to secure an uninterrupted flow of satellite data for global agricultural monitoring, to launch the new assets needed to improve the frequency of monitoring, enabling timely data delivery, to improve data interoperability and implement the required data policies.
In the near term, the CEOS Land Surface Imaging Constellation initiative is being asked to coordinate a concerted data acquisition strategy from the on-orbit Landsat class assets to increase the frequency of coverage, initially for the JECAM Test Sites and subsequently for critical areas of global agricultural production and food insecurity around the world. Help from the CEOS Land Product Validation (LPV) working group will be needed in establishing the protocols for agricultural land cover product validation.

GOFC-GOLD and agricultural Land Use Change

The Global Observations of Forest Cover and Global Observations of Land Cover Dynamics (GOFC/GOLD) is a project of the Global Terrestrial Observing System (GTOS).

The GEO Agricultural Monitoring Task is partnering with GOFC-GOLD, particularly in the area of agricultural land use change.

GOFC-GOLD is involved in setting and promoting observation requirements, developing standards and best practices and promoting new global data products.

The GOFC-GOLD Regional Networks provide an important mechanism for identifying regional priorities, involving regional monitoring communities in the global programs and providing capacity building for enhancing the use of EO data.

GEO Agricultural Monitoring Partnership

GMES

The European Earth Observation Programme (GMES- Global Monitoring for Environment and Security) is aimed at developing European capacity to deliver services on a range of issues including climate change and citizen's security. GMES existing capacities from European Space Agency (ESA), EUMETSAT and individual countries, are complemented by additional EU components to cover the various thematic services (Land, Marine and atmospheric information, climate-change, emergency - Security) at regional and global levels.

The GMES Space Component is comprised of 6 series of earth observation systems (Sentinels 1-5, Jason CS) for a total of 12 missions to be launched in the next 10 years. In order to ensure a continuous data flow easily accessible to users, GMES actively supports the implementation of a free-licensing, open-access data policy for the Sentinels and maintains international cooperation.

GEOLAND 2 (consortium of 50 European partners led by Astrium) prepares the operational capabilities of the GMES Land Service, through the development of Core Mapping Services (CMS) producing basic geo-information on land cover/land use, on annual/ seasonal changes and on biophysical parameters describing the vegetation state and the radiation budget which are of direct interest for Global Agricultural Monitoring.

World Meteorological Organization

As a GEO Partner WMO is being asked to expand the network of meteorological stations in food insecure regions of the World, where the current observation network is sparse.

Capacity Building

For those nations without effective agricultural monitoring systems, capacity building will be needed to ensure the maximum societal benefit from GEO.

A broad range of training and capacity building will be needed, particularly in developing countries to enhance the use of available data and information, establish best practices suited to their national systems and to improve food security.

Amongst many other tasks, the UN FAO is responsible for collecting and compiling national agricultural statistics and increasing the capacity of nations for accurate and reliable reporting. The UN FAO is ideally positioned to help developing nations take advantage of EO data in agricultural monitoring and benefit from the GEO Agricultural Monitoring System of Systems.

31

Global Agricultural Monitoring Community of Practice

(GEO Task: AG-07-03a)

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GEO Home page : http://earthobservations.org/
Global Agricultural Monitoring: http://earthobservations.org/cop_ag_gams.shtml

THE GEO Global Agricultural Monitoring Community of Practice