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Earth Observation for Agriculture Monitoring

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FAO Global Information and Early Warning System on Food and Agriculture (GIEWS)

Monitoring agriculture for market management and food security

Friday, 9 October 2015

European Union Pavilion at EXPO Milano 2015

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FAO Global Information and Early Warning System: What we do?

- monitor **food supply/demand and food security** at **global**, **regional**, **national** and **sub-national** levels
- provide the international community with **current independent information** through a system of regular reports and web-based resources
- provide **early warning** on imminent **food crises** to ensure timely interventions in countries or regions affected by natural or man-made disasters

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FAO Global Information and Early Warning System: Unique features!

- **Global coverage**, with national analysis of varying degrees (145 countries)
- **Extensive data bases** of food security related information:
  - national food balances (production, import/export, utilization for 35 years);
  - retail and/or wholesale price series of major foods consumed in 92 countries and 70 international food commodity price series.
- **Crop and Food Security Assessment Missions** (CFSAMS)
- **Technological innovation**:
  - Tools for analysis with remote sensing data – WinDisp, ASIS
  - Food Price Monitoring and Analysis Tool

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Information Network

- FAO Decentralised Offices
- FAO Country Reps. & Field Projects
- FAO HQ Technical Units
- UN and International Organizations
- Rapid Assessment Missions
- Regional/National Early Warning & Food Information Systems
- National Governmental Institutions & Technical Units
- NGOs
- Private Trade and Industry
- Media

Information Analysis

- Crop Progress/Condition
- Markets & Trade Analysis
- Food Security Analysis
- EO Data Analysis
- National food balances
- Price & Policy Analysis
- Risk mapping
- CFSAMs

Information Dissemination

- Country Briefs
- Special Alerts/Reports
- Crop Prospects, Food Outlook
- Online Databases

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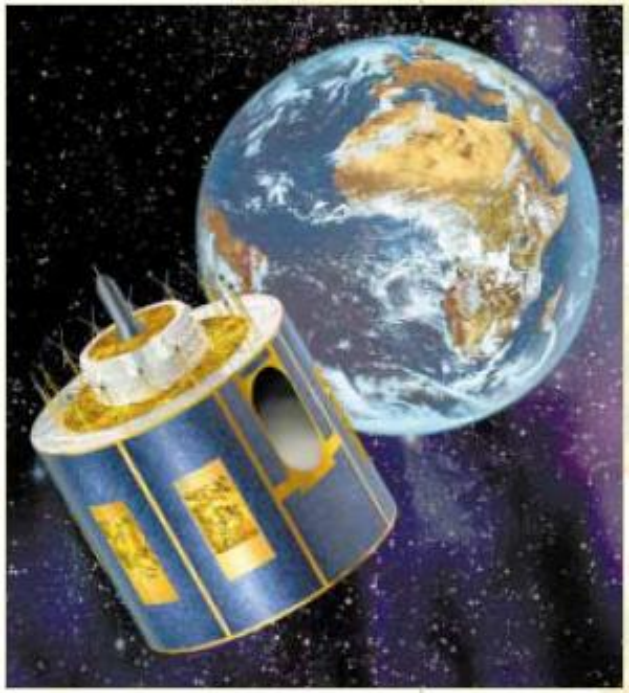
Crop production forecasting

- **Planting area:** seeds, tools, weather, security etc.
- **Crop growing conditions:** weather, pests, disease, inputs, etc.
- **Yield**
- **Harvest area:** weather, security, etc.

Production!

- **Many variables to be monitored on regular basis**
- **Many countries lack continuous reliable information on weather and crop conditions**

Satellite remote sensing



- Satellite remote sensing provides a relatively low cost solution for **monitoring large areas in near real-time**.

- GIEWS began to receive low-resolution satellite products through FAOs Africa Real Time Environmental Monitoring System (ARTEMIS) in 1988.

- Originally the focus of ARTEMIS was on Africa but during the 90s the geographic coverage and the range of products increased. From 1998 the system included imagery at resolutions between 1 to 8 km with global coverage.

Using remote sensing data to monitor agriculture

- **Monitor rainfall to identify areas which are likely to have suffered from drought or excessive wetness:** RFE from CPC of NOAA, ECMWF
- **Monitor the state of vegetation in cultivated and rangeland areas:** Normalized Difference Vegetation Index (NDVI) NOAA 8km , SPOT 1km, METOP 1km
- **Input to models for forecasting/estimating yields of major crops**
- **Estimates of the extent of cultivated land**

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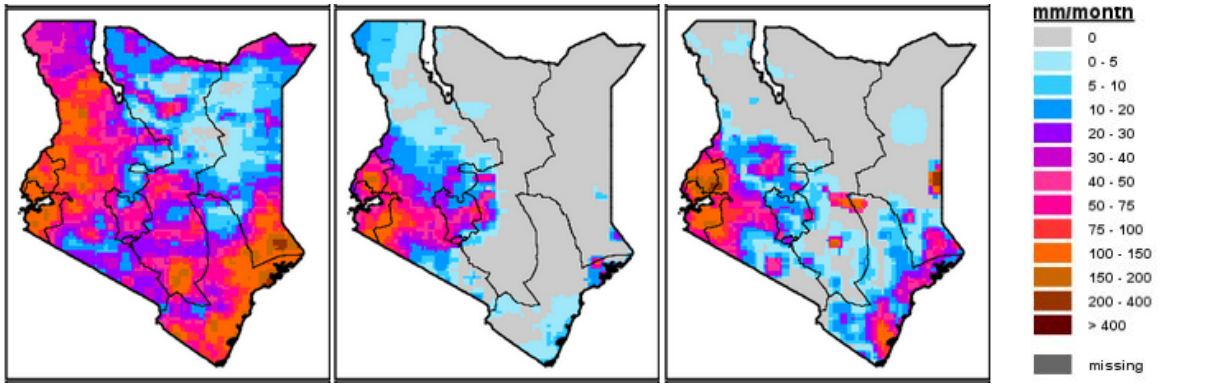
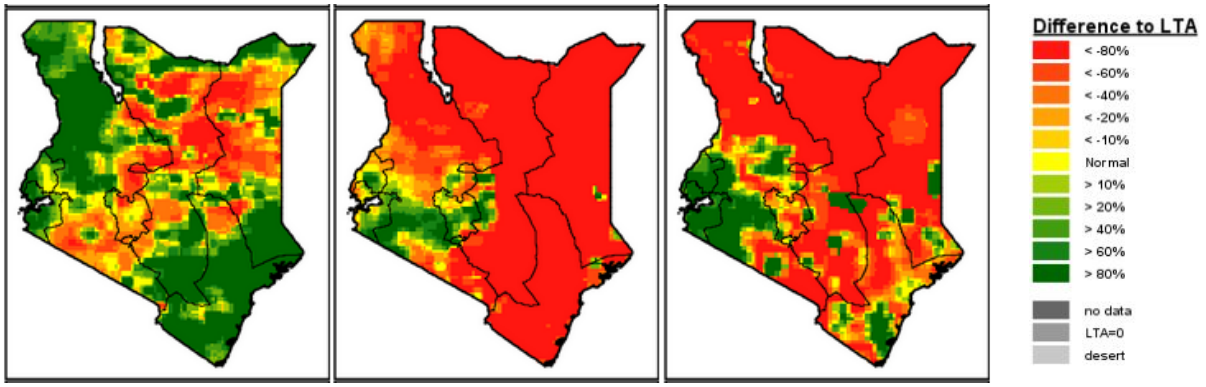
Common traditional techniques of analysis to extract information on crop growing conditions: 1

Visual analysis of image series: often using averaging and difference

Estimated Precipitation
Kenya:
May 2015, dekads 1-3



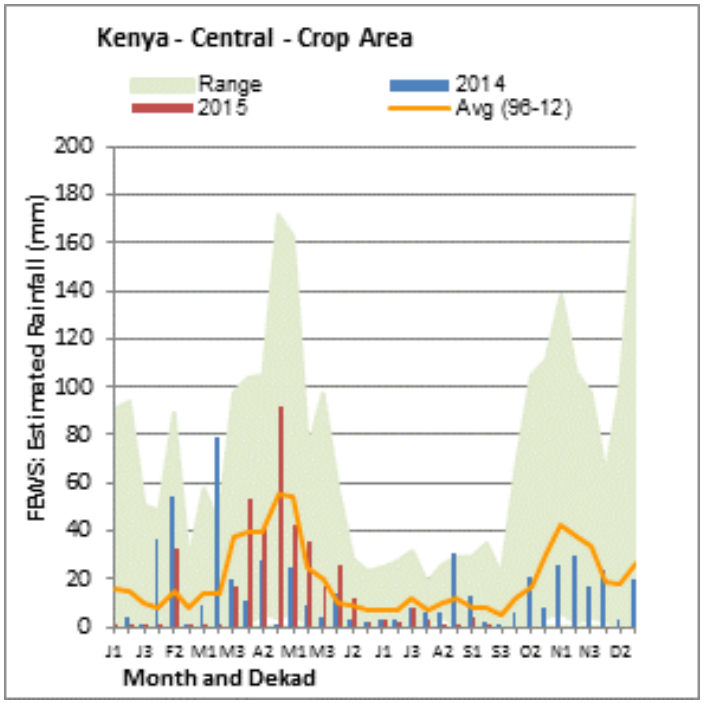
Estimated Precipitation Anomaly
Kenya:
May 2015, dekads 1-3

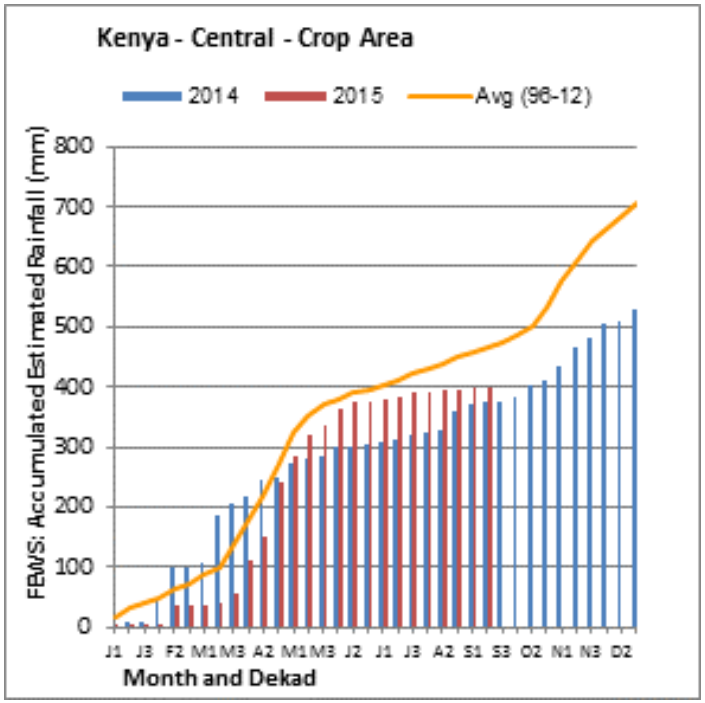


Precipitation data source NOAA/FEWS NET

Common traditional techniques of analysis to extract information on crop growing conditions: 2

Time series analysis





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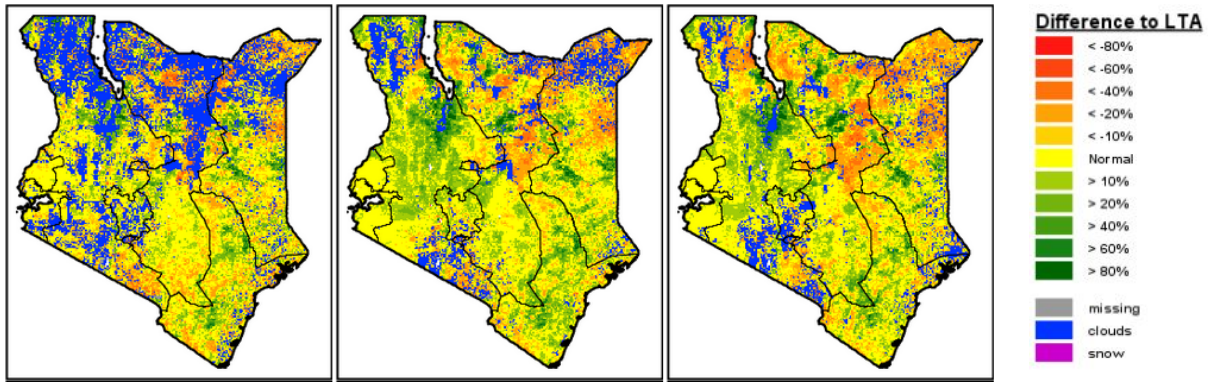
NDVI Anomaly

Kenya:

May 2015, dekads 1-3



2011

- Spot-Vegetation mission providing the 1km NDVI images to end within three years
- What options: no existing solution meeting GIEWS needs for quick access to ready-made, easy to interpret products

"an index integrating remote sensing data to simulate time consuming analysis previously in the domain of the remote sensing expert"

Agriculture Stress Index System (ASIS)

- In 2013 FAO GIEWS and the FAO Climate, Energy and Tenure Division (NRC), based on a pilot study by *Rojas et al* (2010), embarked on a project to develop an "Agricultural Stress Index" (ASI) using remote sensing data to detect agricultural areas with a high likelihood of water stress (drought)
- The system would be Global scale using data from NOAA-AVHRR and METOP-AVHRR at 1km resolution (simulation of METOP pre-2007 using NOAA time series)
- First phase of ASIS was completed and the alpha version was implemented in 2014

Scientific and Technical Partners:

- **The Flemish Institute for Technological Research (VITO)**
- **EC Joint Research Centres (JRC) Monitoring Agricultural Resources (MARS) Unit**

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Vegetation Health Index (VHI) developed by Kogan (1995)

A good indicator of the amount of green vegetation

Vegetation condition index (VCI)

$$VCI_i = \frac{NDVI_i - NDVI_{\min}}{NDVI_{max} - NDVI_{min}}$$

A good indicator of land surface temperature

Temperature condition index (TCI)

$$TCI_i = \frac{BT_{max} - BT_i}{BT_{max} - BT_{min}}$$

Vegetation Health Index (VHI)

VHI = a*VCI + (1-a)* TCI

low VHI

high VHI

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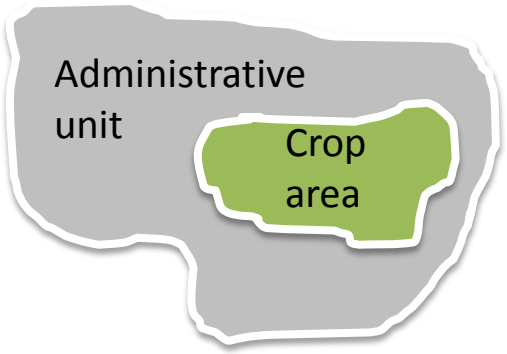
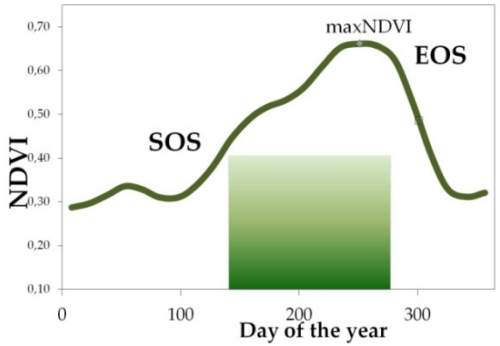
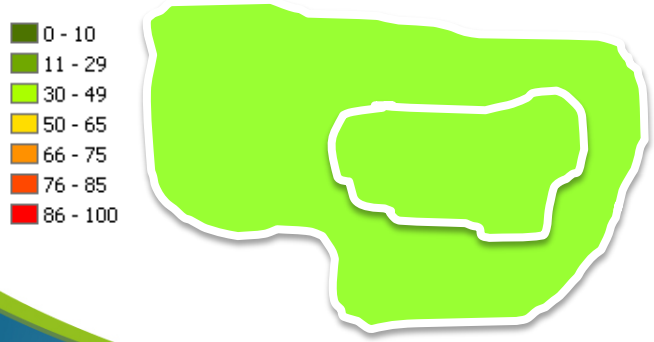
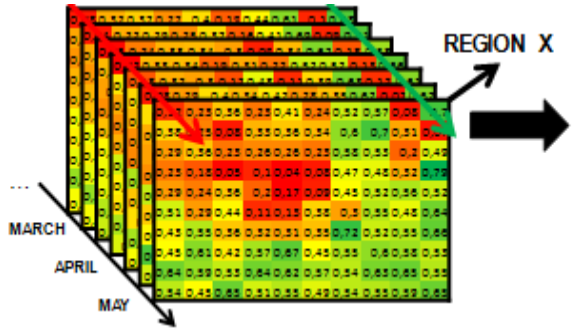
Putting it all together: intensity, duration and spatial extent of the drought





Percent of **crop area** affected by drought: ie % of the agriculture areas with VHI below 35%





Average over season

pixels in crop area < 35%

total pixels in crop

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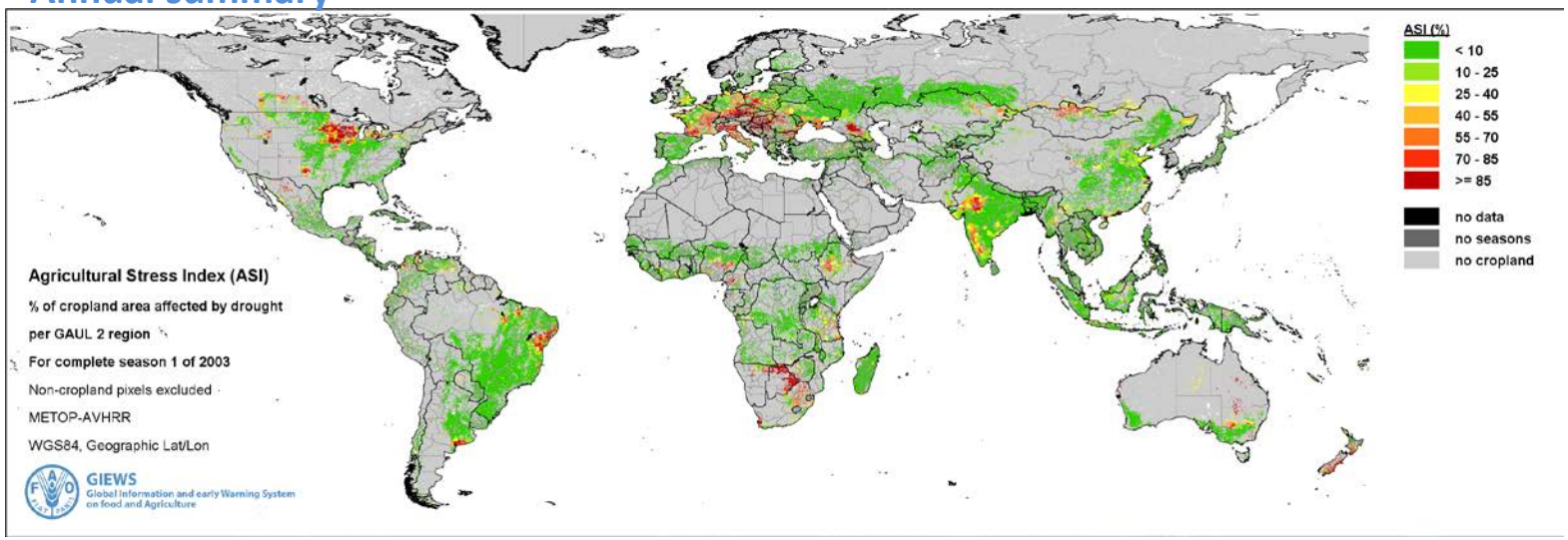
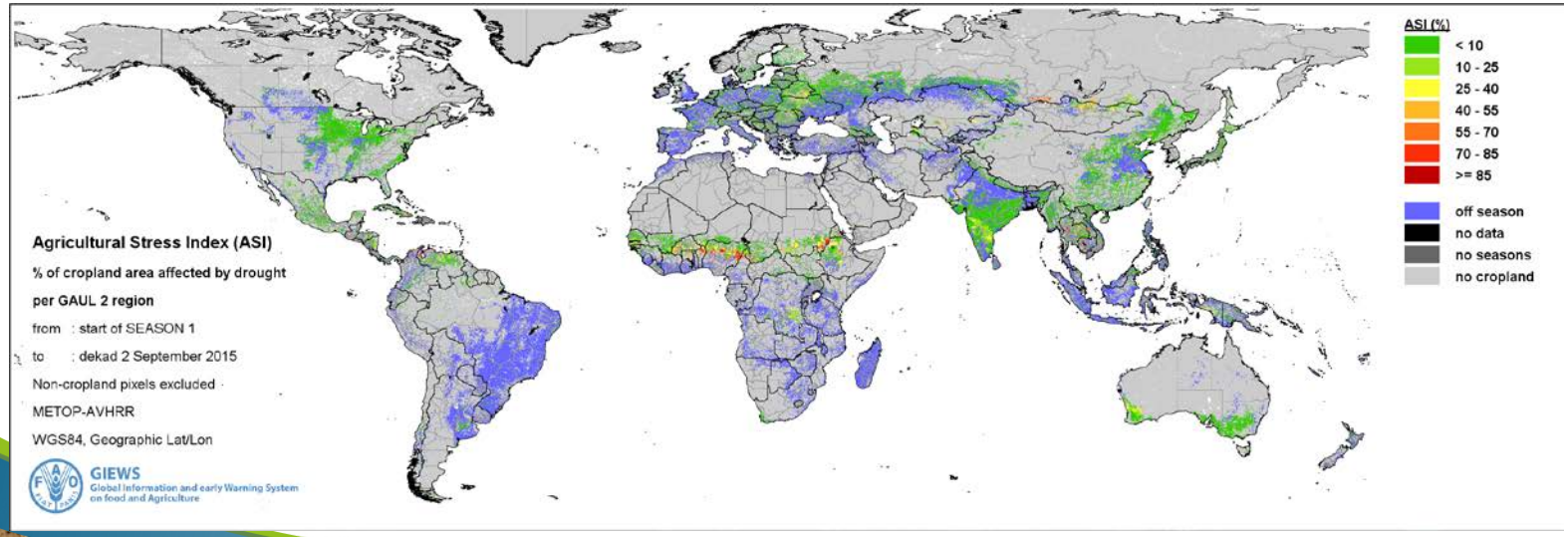
Annual summary



Near-real time



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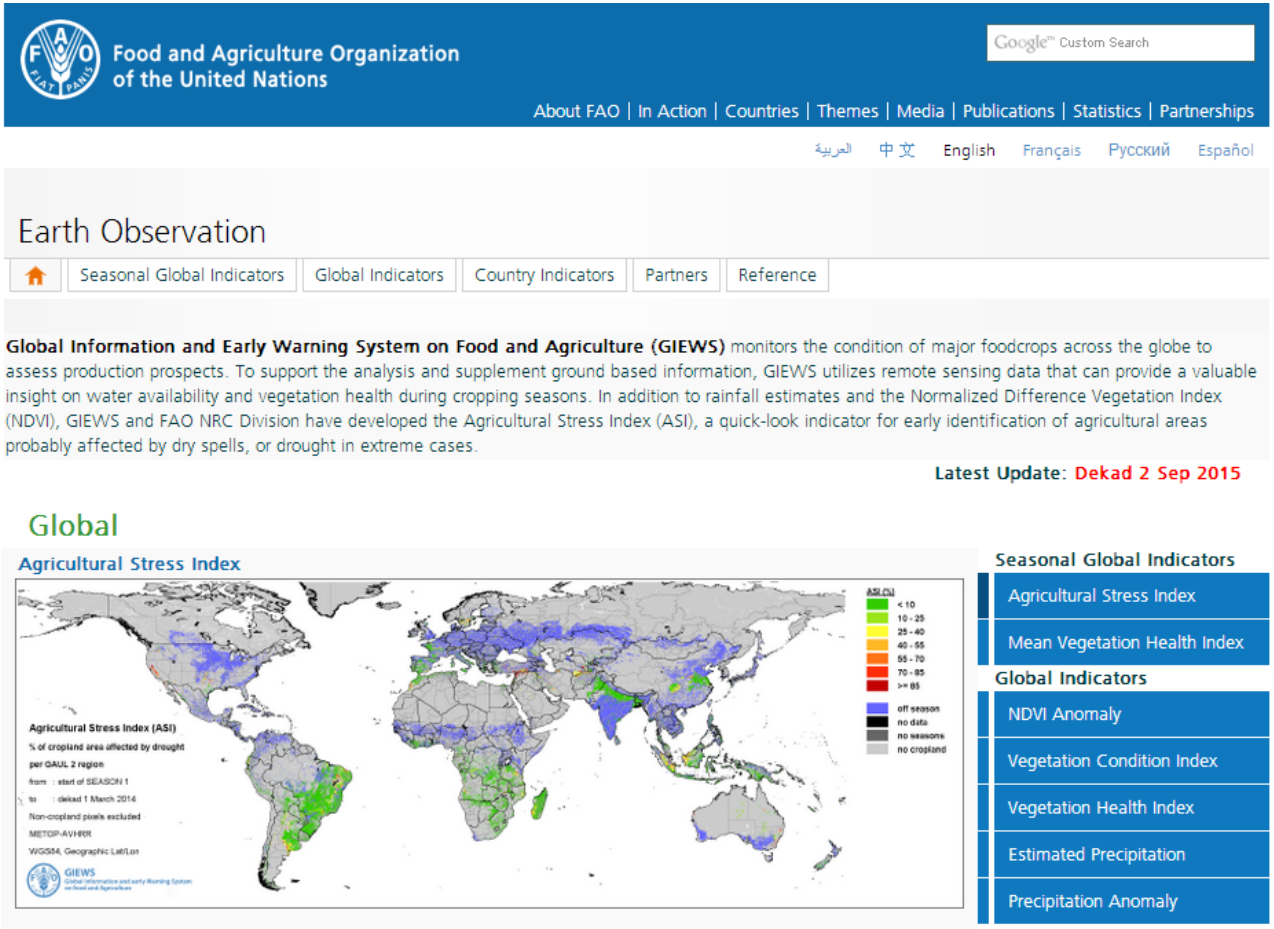

www.fao.org/giews/earthobservation

Advantages of ASIS

- Uses freely accessible remote sensing data (METOP from 2007)
- Has unique time series of **30 years** of vegetation index at **1 km resolution** (simulation of METOP pre 2007 using NOAA time series) ≈10 TB
- Fully automated system generating **5153 quicklook** images every **10 days** in near real time

Outcome

- For the first time, allowed FAO to integrate **temporal** and **spatial** analysis in a remote sensing tool using a **global crop mask**
- Facilitates the **timely access and interpretation** of Earth Observation data to support early warning activities of GIEWS

Further developments ongoing/planned with ASIS

- The development of "standalone" ASIS for supporting specific countries and regions
- Monitoring pasture for semi-arid and arid lands (livestock movements, concentrations mapping etc)
- ASIS Index based insurance for agricultural risk management

The Future: Sentinel-2, CBERS-4,5 etc.

The future holds for us the exciting prospect of much improved access to continuous data flow at high resolution and reasonably low cost, which amongst others would:

- contribute to the improvement of crop masks and the development of **item specific crop masks** (maize, sorghum, rice, pasture etc.) that is expected to improve the correlation between vegetation indices and yield
- contribute to better **delimitation** between **irrigated** and **rain-fed** crop areas

better production forecasts/estimates that are essential for early warning purposes

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Thank You!

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