Anticipating Food Shortages using Satellite Data: examples from the Famine Early Warning Systems Network (FEWS NET)

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Outline

- USAID's Famine Early Warning Systems Network introduction
- How remote sensing contributes to food security analysis and response
- Example of satellite remote sensing used to provide earlier early warning of a crisis
  - Maize in Zimbabwe, 2007-8 season
- Conclusions

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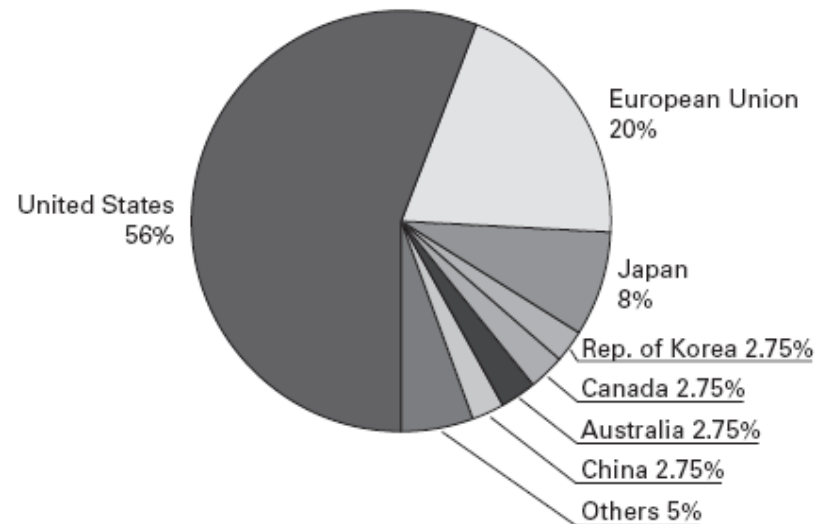
USAID has 2 categories of operations

- **RELIEF for Emergencies (saving lives)**
  - Drought/crop failures
  - Man made disasters
  - Protracted displaced person operations
  - Protracted refugee operations

- **DEVELOPMENT (building resilience)**
  - Agricultural and rural development
  - Human resource development
  - Economic transformation

2004 Global food aid by donor

- United States 56%
- European Union 20%
- Japan 8%
- Rep. of Korea 2.75%
- Canada 2.75%
- Australia 2.75%
- China 2.75%
- Others 5%

Remote sensing is widely used and accepted in **emergency** analysis today. Climate change will bring earth observations and models to the forefront in **development and adaptation** analysis as well.
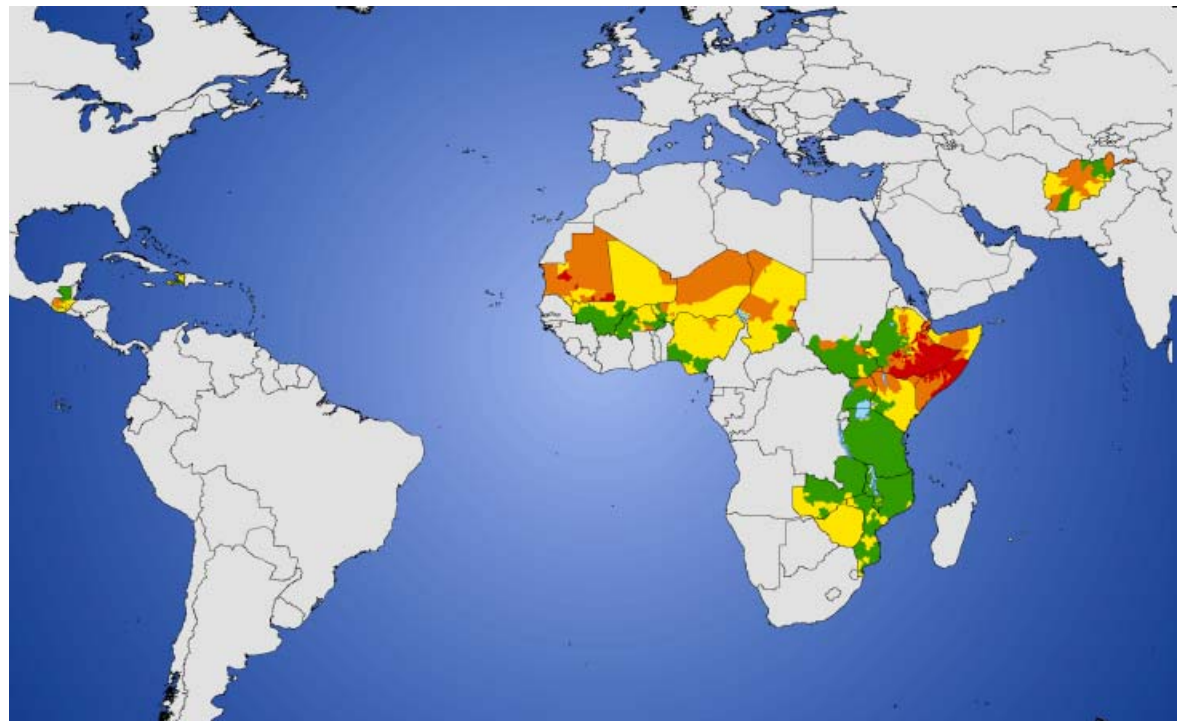
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The Famine Early Warning Systems Network

FEWS NET is a USAID-funded activity that works to strengthen the abilities of countries and regional organizations to manage risk of food insecurity through the provision of timely and analytical early warning and vulnerability information.
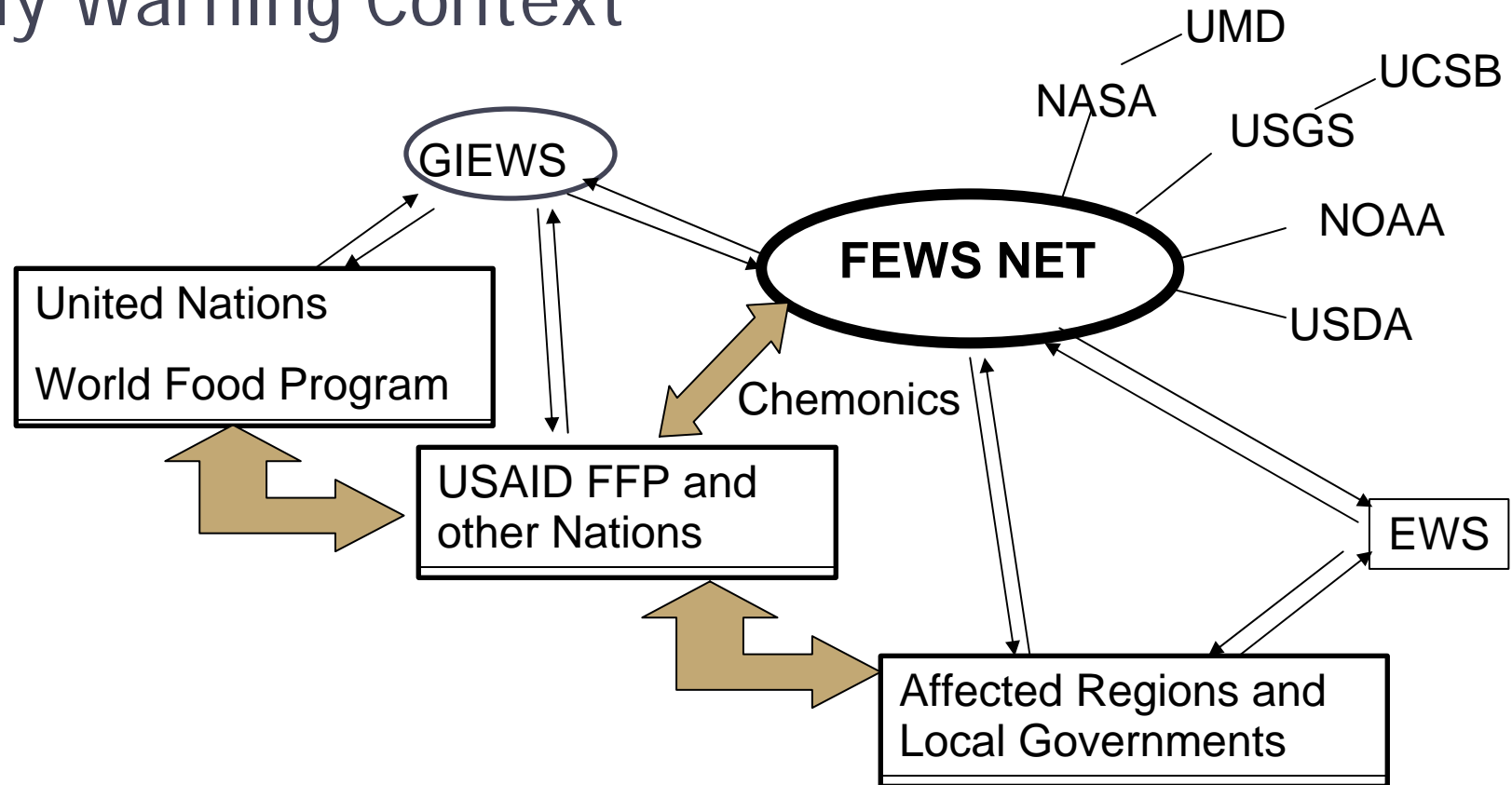
October 20, 2008

Generally Food Secure
Moderately Food Insecure
Highly Food Insecure
Extremely Food Insecure
Famine
No Data
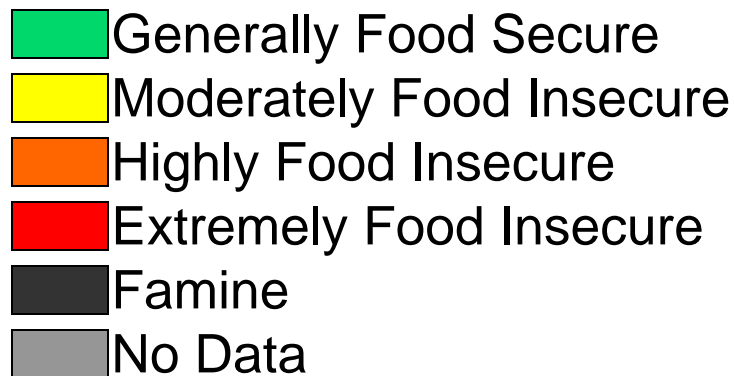
Geographic Extent of
FEWS NET's 23 countries

Early Warning Context

'**Early Warning' (EW)** programs provide Information so Governments can respond to Food Security problems before lives or livelihoods are lost.
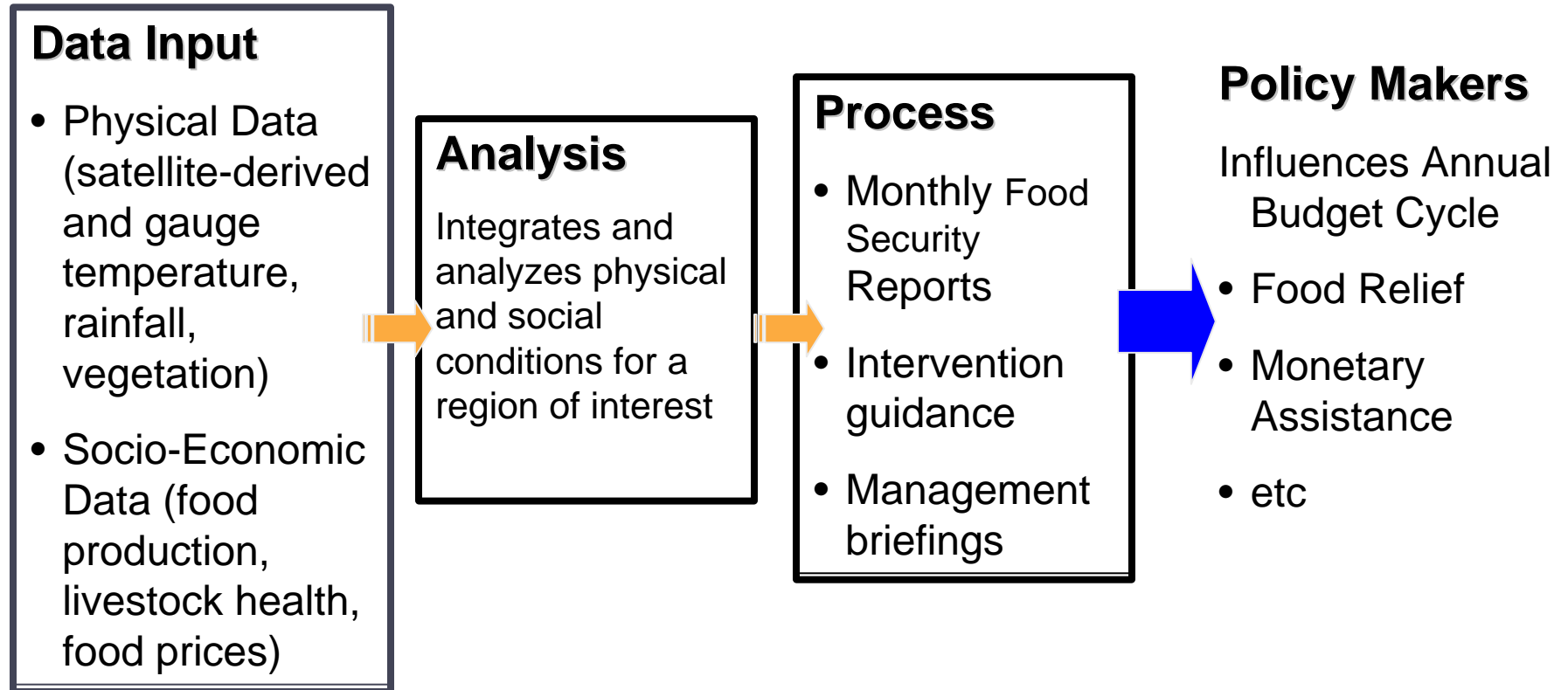
Legend:
GIEWS: Global information and
early warning system
EWS: Local Early Warning Systems
**FEWS NET:** Famine Early Warning System Network

FEWS NET process

Data Input

- Physical Data (satellite-derived and gauge temperature, rainfall, vegetation)

- Socio-Economic Data (food production, livestock health, food prices)

Analysis

Integrates and analyzes physical and social conditions for a region of interest

Process

- Monthly Food Security Reports

- Intervention guidance

- Management briefings

Policy Makers

Influences Annual Budget Cycle

- Food Relief

- Monetary Assistance

- etc

FEWS NET operates in a complex, consensus based decision making environment.

Satellite Imagery for monitoring

Start of Season

Africa Standardized Precipitation Index (SPI)
for the indicated accumulation periods
as of October 10, 2008

NDVI from AVHRR
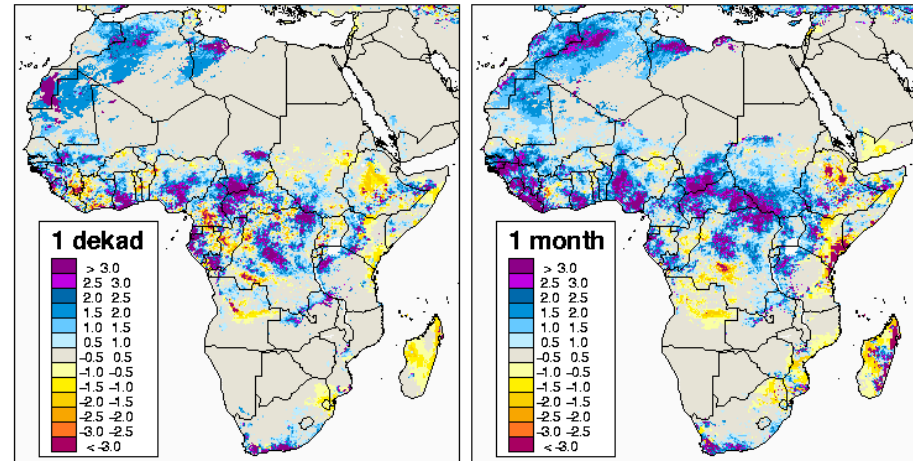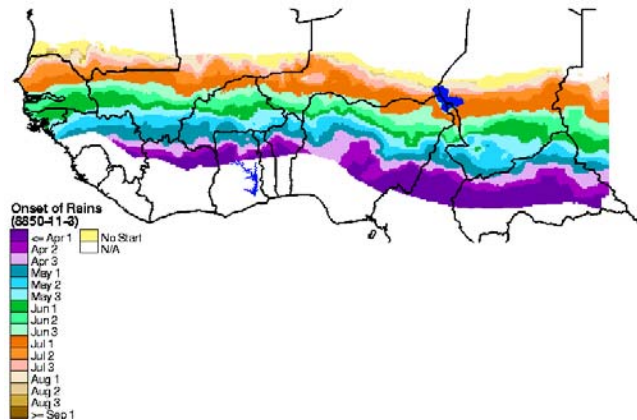
Rainfall (RFE) data

WRSI crop model anomaly for Millet

Diversified and targeted information products
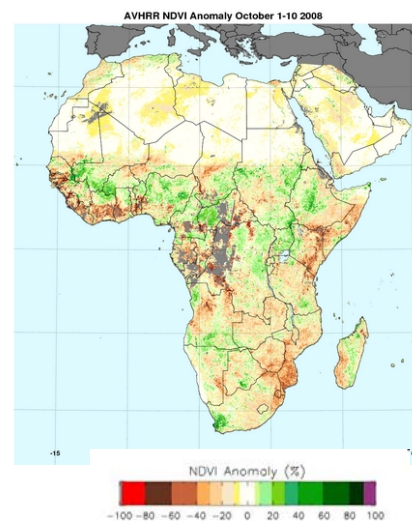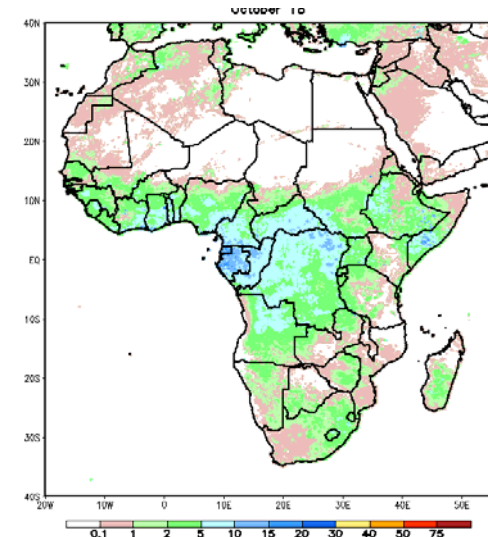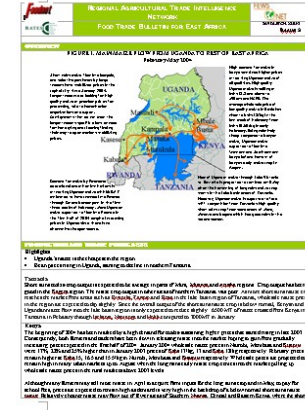
And an integrated early warning information system….

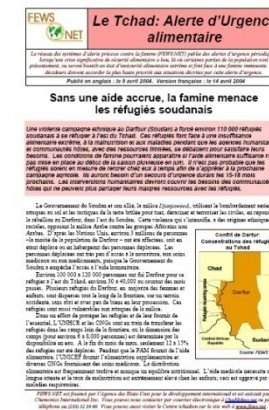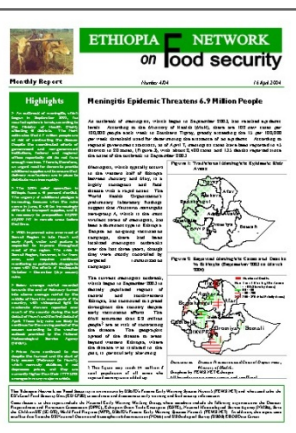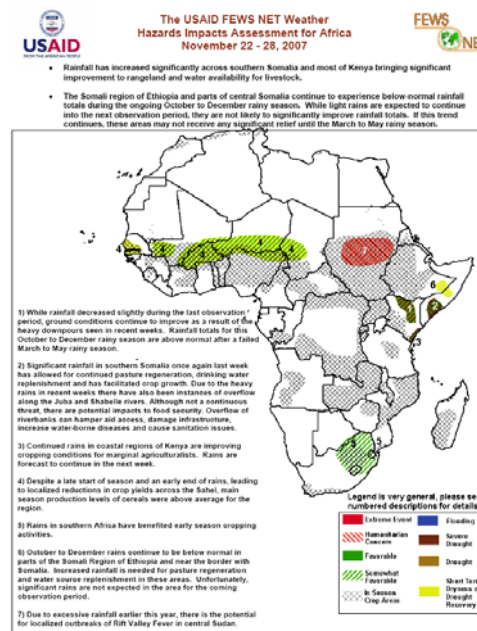Country
Reports

Regional
Reports

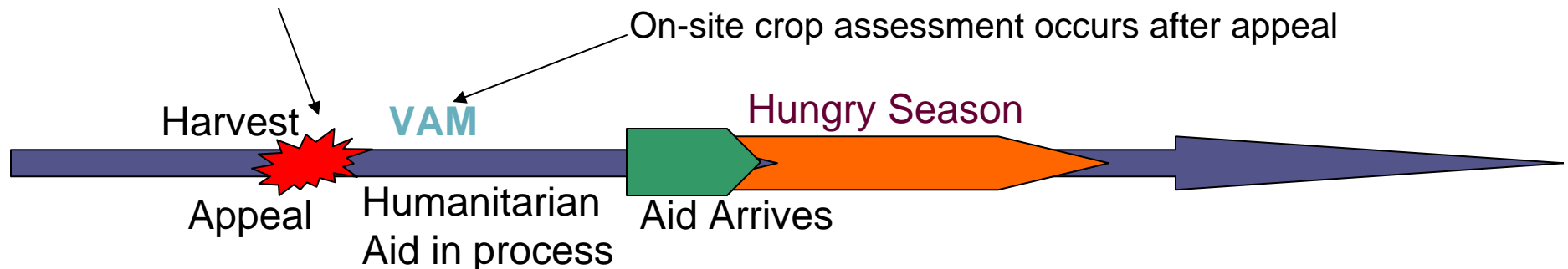Executive
Overview

Alert
Statements

Market/Trade
Information

Remote sensing speeds response

- ## Current Sequence of Events

Vulnerability Assessment Mission

Harvest   VAM   Hungry Season

Appeal   Humanitarian Aid in process   Aid Arrives
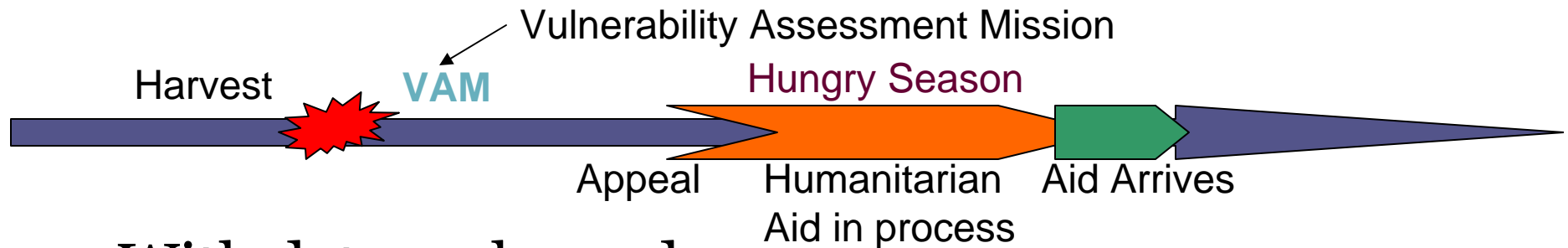
- ## With data on hazard

Remote sensing analysis provides early warning of problem

On-site crop assessment occurs after appeal

Harvest   VAM   Hungry Season

Appeal   Humanitarian Aid in process   Aid Arrives
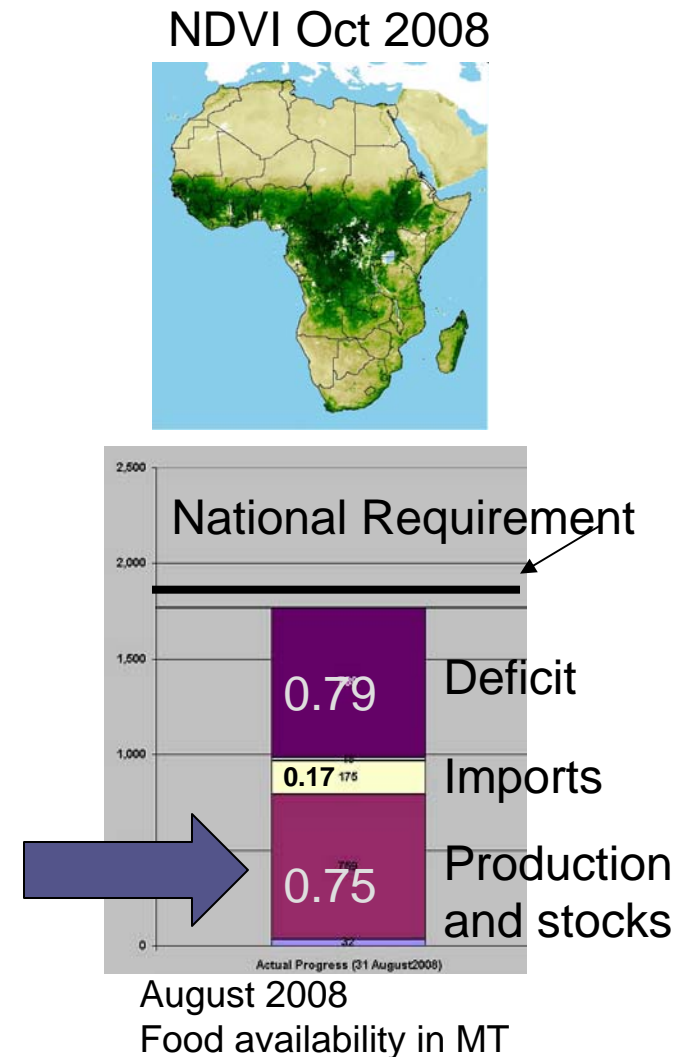
From Menghestab Haile, WFP

Remote sensing provides an Objective Analysis of Hazards for Earlier Early Warning

- Problem specification: identification of potential changes in:
  - Agricultural production (pasture, rain, yields)
  - Value of Assets (livestock through rangeland, market information)
- Remote sensing is by far the earliest source of information that there may be a problem
- It is also the least controversial

Case Study: Vegetation Remote Sensing to estimate production in Zimbabwe

- Zimbabwe has been experiencing a severe economic crisis, coupled with a decline in precipitation and food production
- Extremely high inflation severely reduces the ability of people to purchase grain on the market
- Thus an early and reliable estimate of how much food was produced in April of 2008 to estimate how much aid was needed
- MODIS NDVI data was used to estimate production for aid assessment meeting in Rome

NDVI Oct 2008

National Requirement

0.79 — Deficit

0.17 175 — Imports

0.75 — Production and stocks

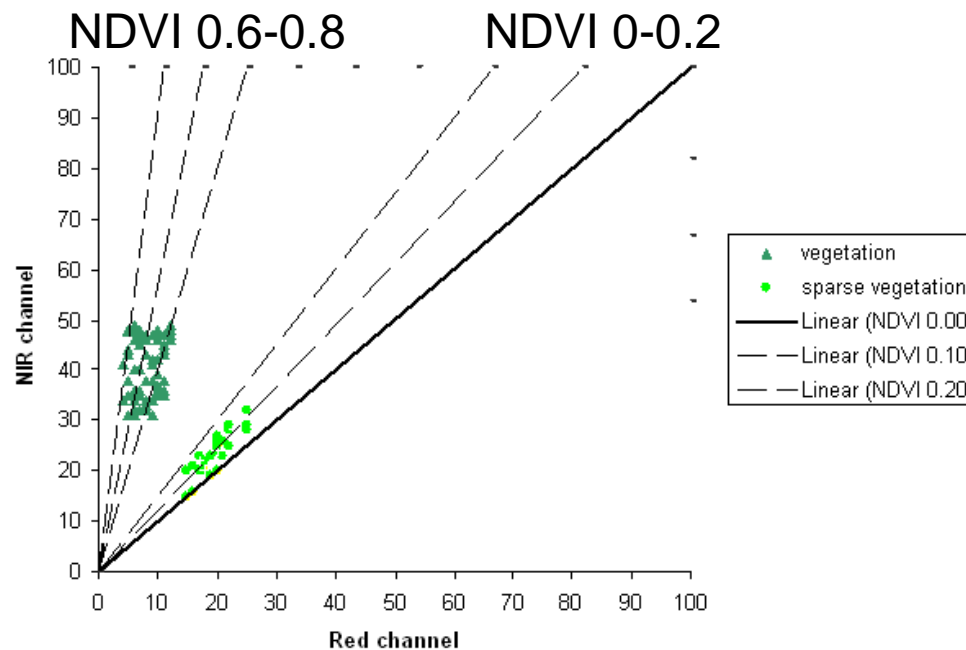Actual Progress (31 August 2008)

August 2008
Food availability in MT

What is NDVI?

The primary index for monitoring vegetation status as a surrogate for pasture and crop production is the
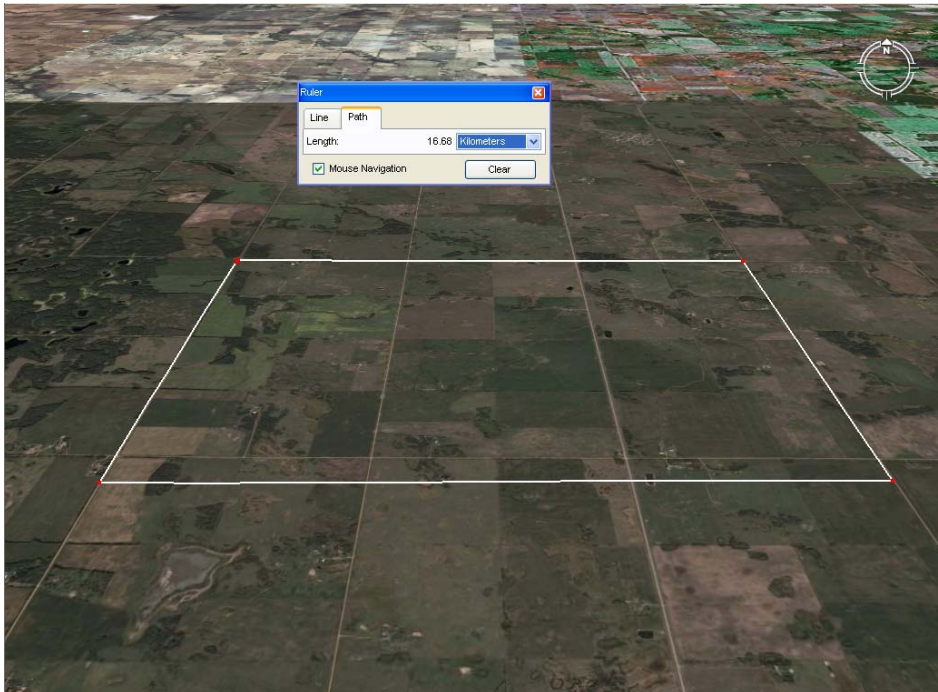
Normalized Difference Vegetation Index (NDVI)

$$NDVI = (NIR\text{-}Red)/(NIR\text{+}Red)$$

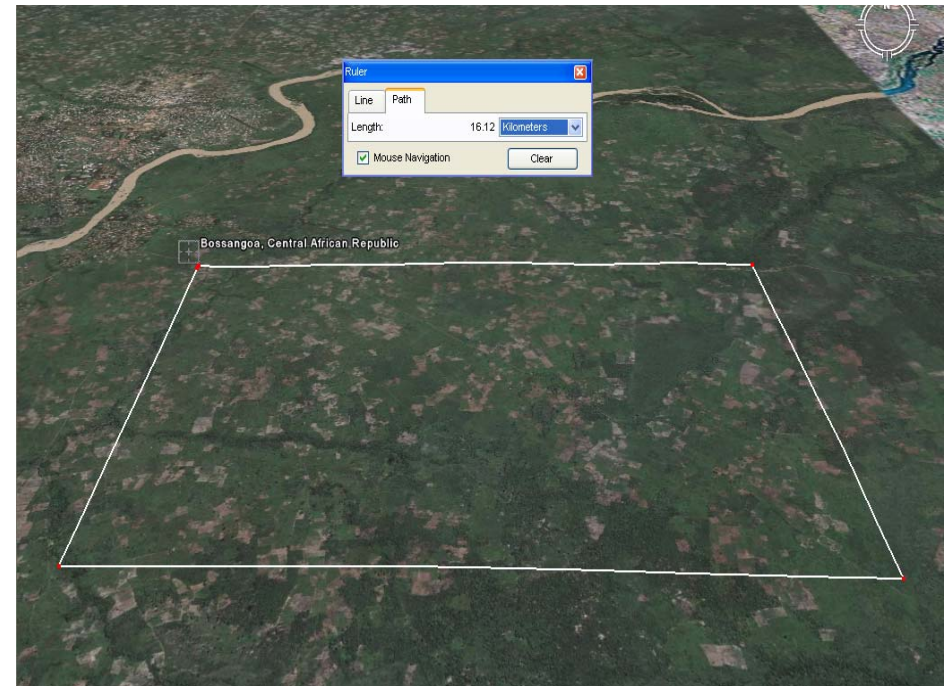a satellite-derived indicator of the amount and vigor of vegetation

What is NDVI?

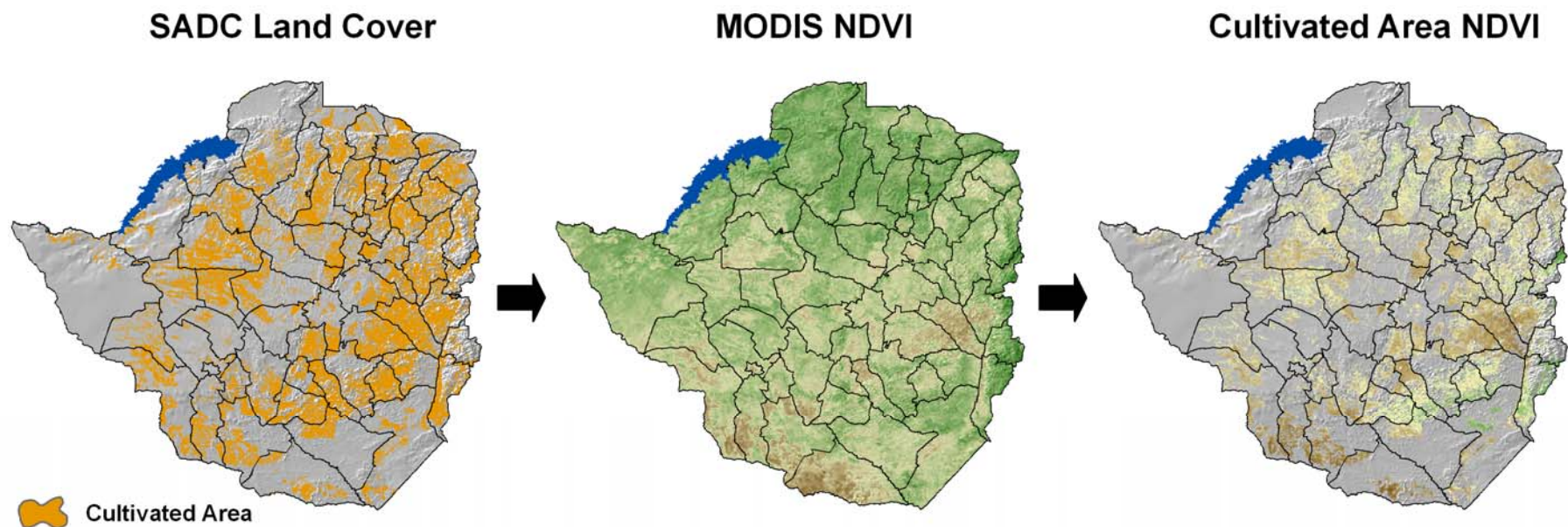In USA and Canada, NDVI can provide a measure of pasture/crop health directly

In Africa, NDVI provides a measure of crop and natural vegetation health

From Pietro Ceccado,
IRI Columbia

The importance of spatially isolating crop growing areas

SADC Land Cover → MODIS NDVI → Cultivated Area NDVI

Cultivated Area

Funk & Budde, RSE, 2008

How NDVI traces can be adjusted phenologically

National maize production figures, produced by the USDA Production Estimates and Crop Assessment Division (PECAD), were used to train and evaluate regression models.

Analysis was done by Chris Funk at the University of California and Mike Budde at the USGS in Sioux Falls.
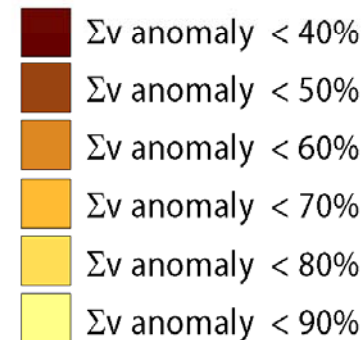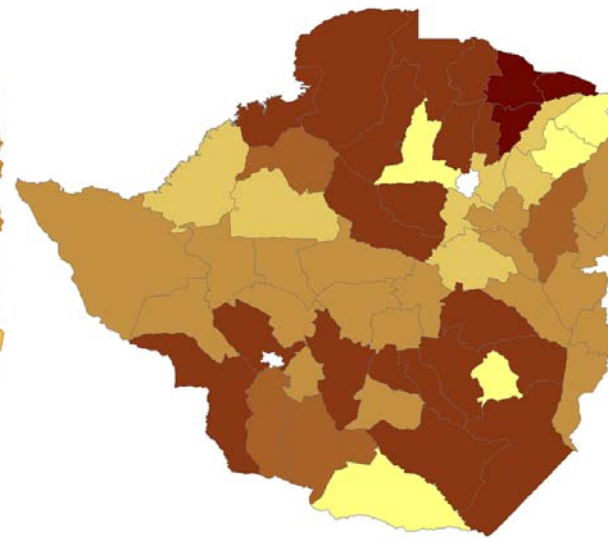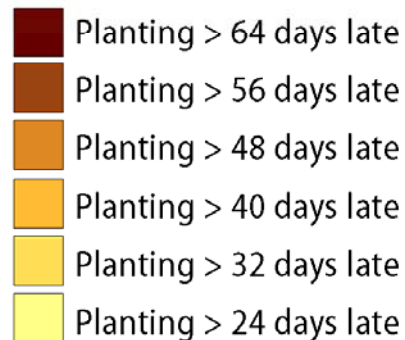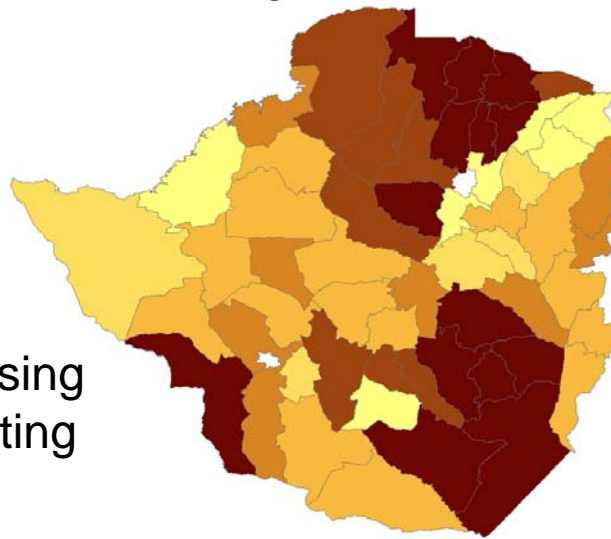
Funk & Budde, RSE, 2008
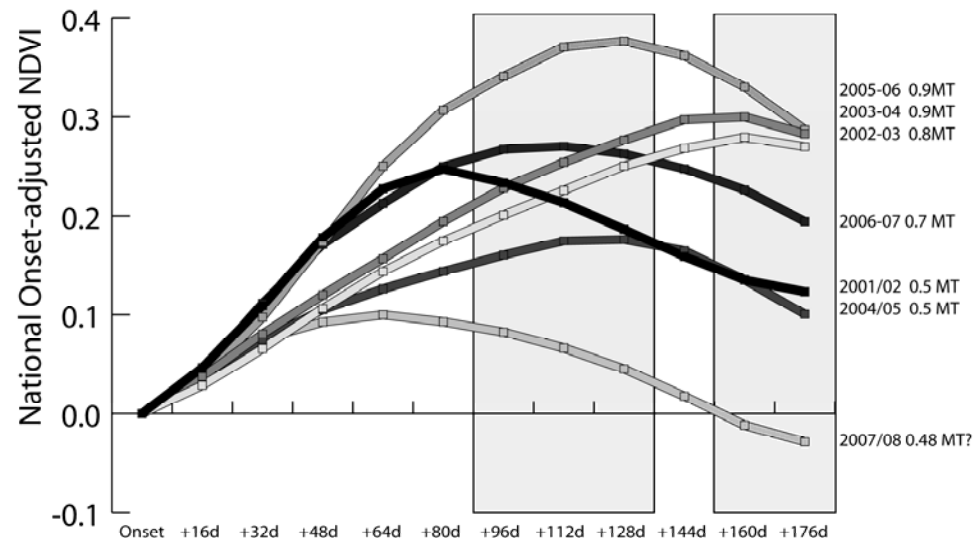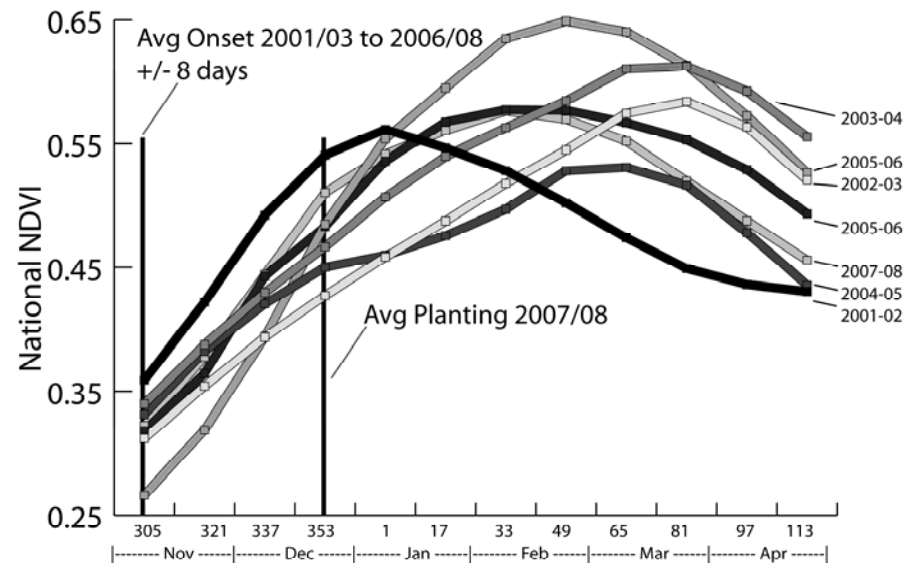
2007/08 planting anomalies and vegetation sum anomalies

2007-8 Planting Anomalies

2007-08 Σv Anomalies

Remote sensing derived planting dates

■ Planting > 64 days late	■ Σv anomaly < 40%
■ Planting > 56 days late	■ Σv anomaly < 50%
■ Planting > 48 days late	■ Σv anomaly < 60%
■ Planting > 40 days late	■ Σv anomaly < 70%
■ Planting > 32 days late	■ Σv anomaly < 80%
■ Planting > 24 days late	■ Σv anomaly < 90%

$$\sum_{onset}^{onset+LGP} ET_i \propto \sum_V = \sum_{onset+lag}^{onset+LAP+lag} (NDVI_t - NDVI_{onset})$$

Funk & Budde, RSE, 2008

How late seed deliveries affected phenologically adjusted Zimbabwe NDVI curves

Fuel shortages coupled with delays in purchasing seeds greatly affected production.

Planting Dates

- Nov 2007/08
- Normal Onset 2006/07
- Dec 2007/08
- Combined 2007/08
- Jan 2007/08

Y-axis: Onset Adjusted NDVI (0.30, 0.15, 0.00, -0.15)

X-axis: Onset +16d +32d +48d +64d +80d +96d +112d +128d +144d +160d +176d

Funk & Budde, RSE, 2008
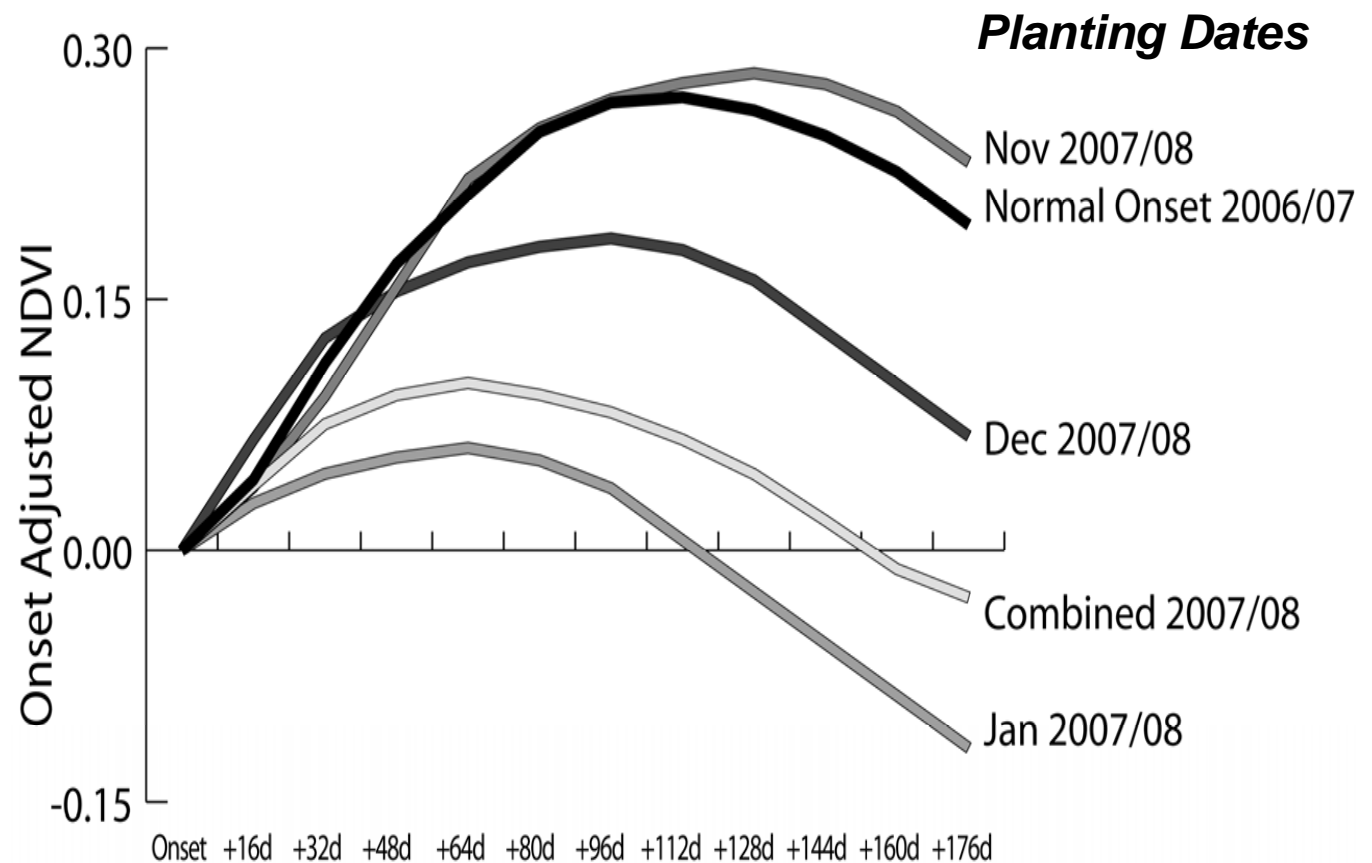
Time series of USDA Zimbabwe production estimates and Vegetation Sum (Σv) production estimates

Funk & Budde, RSE, 2008
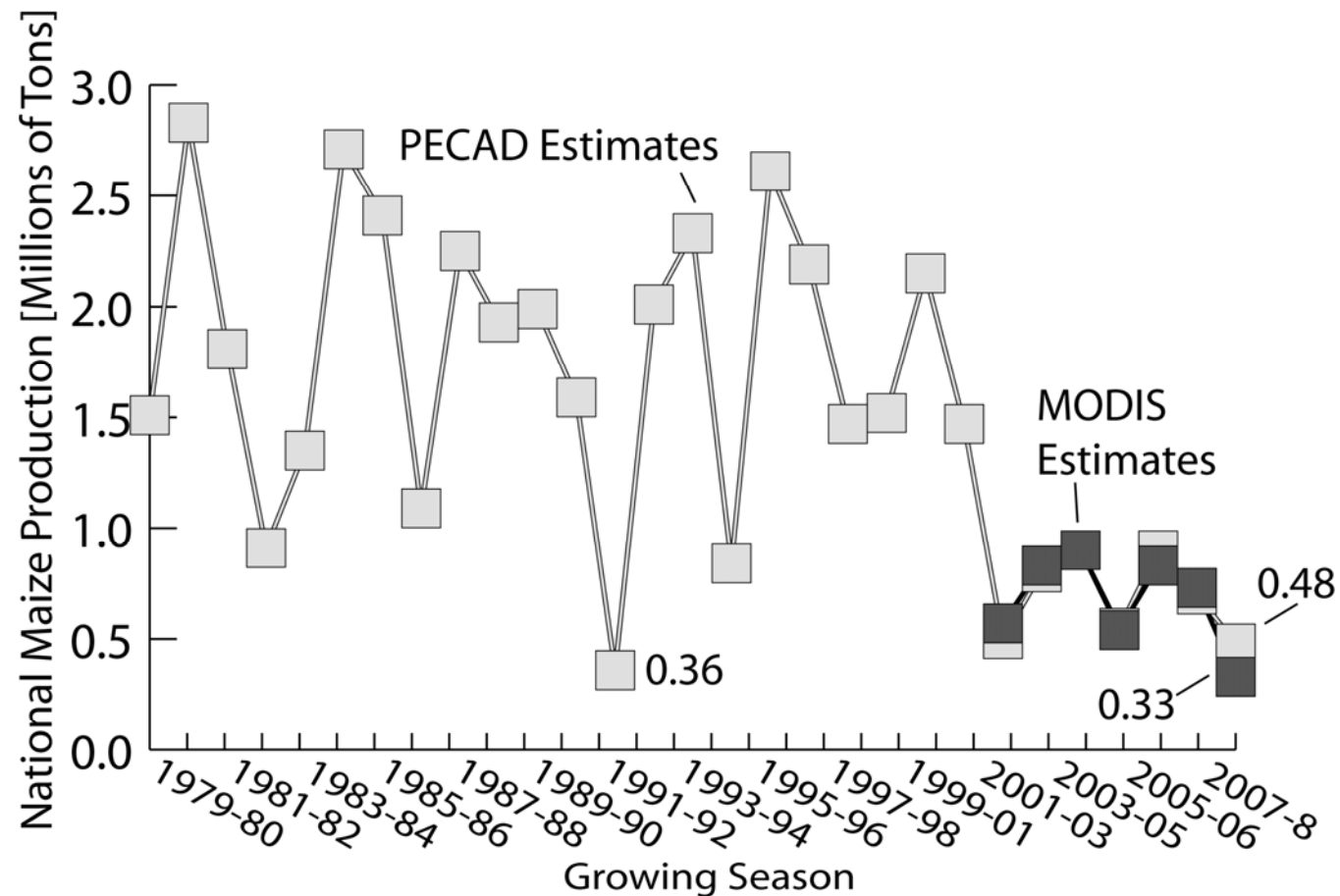
Scatterplot of the USDA Zimbabwe National production estimates vs NDVI-based vegetation sum

These production estimates were used by decision makers from the WFP, ECHO and USAID to estimate how much food will be needed in the coming hungry season. Food will be distributed to three to four million people in rural areas of Zimbabwe as a result.

Funk & Budde, RSE, 2008
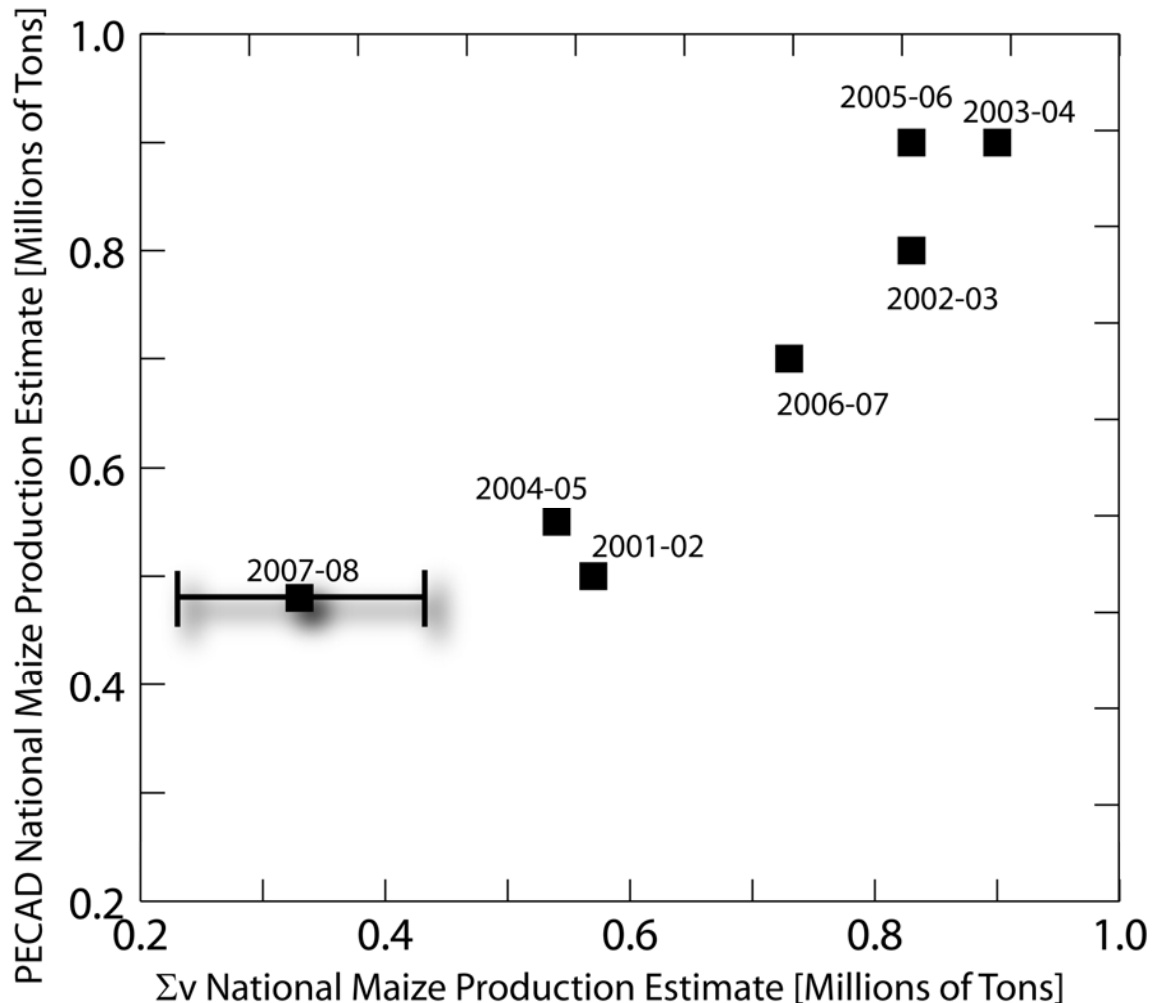
Conclusions

- Food production is critical to the basic food security of millions in Africa
- Remote sensing provides early warning of trouble (impending decline in production)
- Integrated observations and models will provide improved data tools for decision makers – enables the incorporation of non-biological factors into the model for more precise and specific information
- Institutional change may enable earlier response if remote sensing anomalies in well known locations can be used to appeal for aid before a local vulnerability mission is authorized.