Tools for Hazard Monitoring, Assessment, and Response

Jesslyn F. Brown, U.S. Geological Survey, Earth Resources Observation and Science, South Dakota, USA
In the face of hazards, what can people and organizations do to help our situation?

– Better access to information
  • Responsive to a changing situation
  • Have the proper content, latency, spatial detail

– Plan

– Take actions to reduce vulnerability
Specific actions to address hazard management within integrated assessment and planning

1. An assessment of the presence and effect of natural events on the goods and services provided by natural resources

2. **Estimates of the potential impact of hazard events on development activities**

3. Include measures to reduce vulnerability in the proposed development activities
• Drought is a kind of climate hazard, and it is one that dramatically effects agriculture.
• Generally more costly than other hazards especially when we consider the impacts and costs at multiple scales.
• Multiple tools are needed to access information about hazards – Where, When, How severe?
• Remote sensing is one tool
Remote Sensing Advantages

Cost-effective and rapid of acquiring up-to-date information over a large geographical area
Practical way to obtain data for inaccessible places
High repetition rate and continuous coverage (time and space)
Standard methods and techniques

Remote Sensing Limitations

Indirect measure of the phenomena
Atmosphere noise needs to be corrected
Geometric and sensor calibration issues
Satellite Systems

AVHRR

MODIS

Data Services

Existing

Data Translation

EMODIS System

Georegistration Compositing Surface Reflectance

Stacking Smoothing Anomaly Detection Metrics Calculation (SOS, SG, PASG)

Vegetation Dynamics System

Vegetation Dynamics and VegDRI Models

User/Decision Support System

Data/products to partners >>
Regular and Quick

U.S. Drought Monitor March 31, 2009

USGS science for a changing world
USDA: 2012 Drought the cause of decreasing crop production

Despite getting off to a very favorable start, U.S. growers spent the summer of 2012 battling historic drought conditions in much of the Midwest. As a result, corn and soybean production, both key U.S. crops, is significantly down in 2012, according to the Crop Production 2012 Annual Summary released Friday by the U.S. Department of Agriculture’s National Agricultural Statistics Service (NASS).

Higher Food Prices Likely As Drought Worsens

Drought in US Intensifying to 'Historic Proportions'
- Common Dreams staff

WILDFIRES:
For much of U.S., fire hazard lingers as drought persists

Nathanael Massey, E&E reporter
ClimateWire: Friday, December 7, 2012

An unusually late fire season may bring coalitions between fire and drought than a few Christmases this year. Ongoing drought conditions across much of the West, Midwest and South have left ample fuel for ignition, keeping firefighters on edge and raising the threat risk.
Drought Impacts

• Annual direct losses to the U.S. due to drought are, on average, $6-8 billion (FEMA) 2012 $$150 billion

• Drought severity can be significantly under- or over-estimated due to inadequate drought observations. This affects Planning, Prediction, Mitigation, and Response.

• Impacts are evident at multiple scales (local, regional, national, global) and in multiple sectors
## Drought Impacts

The table below illustrates the impacts of drought on various scales:

<table>
<thead>
<tr>
<th>Scale</th>
<th>Global/ Multinational</th>
<th>National</th>
<th>Regional</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Food Supply</td>
<td>Food Prices Distribution</td>
<td>Foreign Economies</td>
<td>Famine Social Conflict</td>
<td></td>
</tr>
<tr>
<td>U.S. Food Supply</td>
<td>Food Prices Distribution</td>
<td>National Economy</td>
<td>Trade Balance Inflation</td>
<td></td>
</tr>
<tr>
<td>Regional Production</td>
<td>State/Regional Economic Productivity</td>
<td>Migration Tax Base</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yields</td>
<td>Farm Income</td>
<td>Health problems Bankruptcy Service</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Impacts
- **Agricultural:**
  - Yields
  - Farm Income
- **Economic:**
  - State/Regional Economic Productivity
  - Trade Balance
  - Tax Base
  - National Economy
- **Social:**
  - Global/Regional Economic Productivity
  - Foreign Economies
  - Famine
  - Famine
  - Social Conflict

*Warrick and Bowden, 1981*
Historical Departures From Trend Yields for U.S. Corn
1866 to date

Year

Pct. departure from trend yield

-40%
-30%
-20%
-10%
0%
10%
20%
30%

1881 -24.4%
1894 -22.0%
1901 -29.5%
1934 -25.8%
1936 -26.2%
1983 -21.9%
1988 -25.4%
2012 -22.5%

Yield data adapted from USDA-NASS
2012 trend yield = 159 bpa
2012 est. as of Aug 2012 = 123 bpa

USGS
science for a changing world
Historical Departures From Trend Yields for U.S. Corn
1866 to date

Year | Pct. departure from trend yield
--- | ---
1881 | -24.4%
1894 | -22.0%
1901 | -29.5%
1934 | -25.8%
1936 | 26.2%
1983 | -21.9%
1988 | 25.4%
2012 | -22.5%

Yield data adapted from USDA-NASS
2012 trend yield = 159 bpa
2012 est. as of Aug 2012 = 123 bpa

Dust Bowl: 1934, 1936

XIII FORO DE EXPECTATIVAS

USGS
science for a changing world
Historical U.S. Corn Grain Yields
1866 to date

Data source: USDA-NASS
2012 yield est. as of Aug 2012
### U.S. requirements for *operational* drought monitoring—geospatial products

<table>
<thead>
<tr>
<th>Product coverage</th>
<th>National synoptic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product schedule</td>
<td>Weekly, circa Monday a.m.</td>
</tr>
<tr>
<td>Spatial scale</td>
<td>1-4 km², sub-county details</td>
</tr>
<tr>
<td>Product latency</td>
<td>&lt;24-48 hours</td>
</tr>
<tr>
<td>Length of record (providing climatology)</td>
<td>~30 years for climate data, information framed related to climatology or history</td>
</tr>
</tbody>
</table>
Start of Season
End of Season
Length of Season
Seasonal “greenness” – cumulative productivity

Multi-year time-series observations support National monitoring of land change

Normalized Difference Vegetation Index (NDVI)

Seasonal Metrics Derivation

USGS
science for a changing world
Integrating Satellite and Climate Data

• **Seasonal greenness condition** from satellite highlights areas with anomalous vegetation condition
  — *Deficits* (compared to average condition) might be caused by *drought*, flooding, late greennup, land cover conversion, etc.

• **Climate information** is needed to provide evidence that enables interpretation of the satellite data anomalies
Vegetation Drought Response Index Methodology

1. **Historical Database Development**

   - **Satellite Data**
     - Data Input Variables
       - 1) Percent Annual Seasonal Greenness (PASG)
       - 2) Start of Season Anomaly (SOSA)

   - **Climate Data**
     - 1) Palmer Drought Severity Index (PDSI)
     - 2) Standardized Precipitation Index (SPI)

   - **Biophysical Data**
     - 1) land use/land cover type
     - 2) soil available water capacity (STATSGO)
     - 3) ecoregion type
     - 4) irrigation status
     - 5) elevation

2. **Model Development**

   - Regression Tree Model (*)

3. **Map Generation**

   - 1-km² VegDRI Map

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* Models developed from a 20-year historical record (1989 – 2009) of climate and satellite observations at 3,000+ weather station locations.

Biophysical variables are *static* over time.
VegDRI Flow: Providing Near-real time Delivery of Information

- Terra MODIS
- MODIS L0 Data
- MODIS L2, L1B Data
- MODIS Expedited
- LAADS
- eMODIS Historical

Input Data Target:
Monday 10:30 a.m.

- USGS Drought Monitoring
- NIDIS Vegetation Drought Response Index
- NIDIS Drought Portal
- U.S. Drought Monitor

Flow: Providing Near-real time Delivery of Information
8-day Cumulative ETa Anomaly
Apr 1 – Sep 12, 2012

Courtesy: G. Senay
2001, 2006 National Land Cover Datasets

20 LC Classes
Only 2 Agricultural Classes

~78% Overall Accuracy
Information for decision-makers through combinations of Information/data
Crop Type Classification of the U.S. Great Plains: An Application of Regression Tree Modeling using Remote Sensing and Environmental Data

- Spatial coverage: U.S. Great Plains
- Temporal coverage: 2000 – 2011
- Spatial resolution: 250 meter
- Overall model classification accuracy: 87%
- Linear agreement with county results from the USDA NASS Survey Program: $R^2 = 0.76$

D. Howard, B. Wylie
Global Agricultural Monitoring System of Systems:

• GEOSS Activity

• Satellite observations, in-situ observations and model outputs are needed.

• Standardization and coordination among countries

• Combined information (seasonal forecast models, agro-meterological data [precip, temp, humidity], in-situ obs, satellite obs at various scales, optical, thermal, microwave...)

• Planted area, crop condition, crop type, crop yield
Summary

• Remotely sensed observations (spatial detail and synoptic coverage) are a critical tool for monitoring hazards
• Need to understand limitations and accuracy
• Need for continued development of tools that fit national needs, and also enhance a global system
• International cooperation and technical advancement is being supported through GLAM
Thank You!  Muchos Gracias!

Questions?  Preguntas?