From the Global Agriculture Drought Monitoring to Country Level using Geospatial Information

In collaboration with:

Losses due to Drought are concentrated on the Agricultural Sector (58%)

CENTROAMÉRICA: PERDIDAS OCASIONADAS POR LA SEQUÍA 2001

AGRO RONDA EL 60% EN SEQUÍAS

Electricidad 25%

Emergencia 7%

Agrícola 58%

Agua potable 2%

Industria 8%
Objective

Limitation using rainfall data:

• Currently weather stations are sparse and provide discontinuous data
• Rainfall estimates have a bias and show deviations in different regions of Africa (Dinku et al. 2007, Lim and Ho 2000).

What ASIS is?

• Is a expert system for agricultural drought monitoring based on 10-day satellite data of vegetation and land surface temperature from METOP-AVHRR sensor at 1 km.
Electromagnetic energy recorded by the sensor

<table>
<thead>
<tr>
<th>Emergence</th>
<th>Tassel</th>
<th>Silk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment (0)</td>
<td>15-25 days</td>
<td>35-45 days</td>
</tr>
<tr>
<td>Vegetative (1)</td>
<td>25-40 days</td>
<td>10-15 Days</td>
</tr>
<tr>
<td>Flowering (2)</td>
<td>15-20 days</td>
<td></td>
</tr>
<tr>
<td>Yield Formation (3)</td>
<td></td>
<td></td>
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<tr>
<td>Ripening (4)</td>
<td></td>
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</tr>
</tbody>
</table>
ASIS assess the severity (intensity, duration and spatial extent) of the agricultural drought.
<table>
<thead>
<tr>
<th>Year(s)</th>
<th>Country/region</th>
<th>Impact</th>
<th>ASI Map</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>Sahel</td>
<td>During the crisis, an astounding 20 nations of Africa were under severe drought. Entire rivers and lakes completely dried up. Up to 20,000 people starved to death each month. Although the total number of people who perished is not completely known, it is estimated that over 1 million people died as a direct result of the drought. The worst drought in the Sahel during the early-mid 1980's occurred the year 1984 affecting most Sahel countries (Nicholson, 1985).</td>
<td><img src="image1" alt="ASI Sahel Map" /></td>
</tr>
<tr>
<td>1986</td>
<td>India</td>
<td>In 1986 and 1987, India experienced severe drought (Nathan, 1994). During September and October 1986, the entire state of Haryana was hit by a drought. Crops like bajra, sugarcane, paddy, and pulses, worth a total of Rs. 100 crores, were damaged. In 1987, the drought situation was at its worst from June to August. Paddy sowing was done in only 40% of the area of Haryana. The 1987 drought affected 6,351 villages with a total population of more than 9 million, more than 1.4 million ha cropped area, and more than 5 million cattle. For drinking water alone, Rs. 3.70 crores assistance was given by the Indian government (Misra, 2003).</td>
<td><img src="image2" alt="ASI India Map" /></td>
</tr>
<tr>
<td>1988</td>
<td>United States</td>
<td>In the United States a severe droughts occurred during 1988 and 1989 (U.S. General Accounting Office, 1989). Following a milder drought in the Southeastern United States and California the year before, the 1988 drought spread from the Mid-Atlantic, Southeast, Midwest, Northern Great Plains and Western United States (U.S. Congress, 1988). This drought was widespread, unusually intense and accompanied by heat waves which killed around 4800 to 17000 people across the United States and also killed livestock across the United States. One particular reason that the Drought of 1988 became very damaging was farmers might have farmed on land which was marginally arable. Another reason was pumping groundwater near the depletion mark. The Drought of 1988 destroyed crops almost nationwide, residents' lawns went brown and water restrictions were declared many cities. This drought was very catastrophic for multiple reasons; it continued across the Upper Midwest States and North Plains States during 1989, not officially ending until 1990. The both droughts also affected Canada in certain divisions.</td>
<td><img src="image3" alt="ASI United States Map" /></td>
</tr>
<tr>
<td>1992</td>
<td>Southern Africa</td>
<td>The 1992 Southern African drought was the region's worst drought in living memory. Many wells and some perennial rivers dried. Well over a million cattle died: 1.03 million in Zimbabwe alone, more than 23% of the national herd (Tobaiwa, 1993). The drought affected around 86 million people in the 10 countries which then comprised SADC, of whom around 20 million people were estimated to be at serious risk’ (SADC, 1993). Aggregate cereal production in the nine severely affected countries (including South Africa) was 38% of the previous five-year mean, and only 22% in Zimbabwe, often an exporting country. Cereal imports into the 10 SADC countries and South Africa more than tripled during 1992/3, from 3.3 to 10.5 million tonnes (Clay, 1995).</td>
<td><img src="image4" alt="ASI Southern Africa Map" /></td>
</tr>
</tbody>
</table>
GIEWS Earth Observation Website

http://www.fao.org/giews/earthobservation/
Standalone ASIS

funded by:
Global ASIS FAO HQ

Input data

Country/regional ASIS

VHI = a VCI + b TCI

Weighted VHI from SOS to EOS

% area with wVHI in each Drought Category

Cumulative Weighted VHI (cwVHI) from SOS to EOS

Introduction of threshold of critical cwVHI and probability calculation

Export to Excel % of each Drought Category by administrative unit

Probability of deficit as defined by threshold (Quick look map)

Calculation % area with wVHI < 35 (Quick look map)

Quick look maps of each Drought Category

Calculation wVHI using ASI as a weighted factor for each Drought Category (Quick look map)

External inputs a and b

ROI (lat, long) of VCI, TCI, SOS, EOS, POS

National database and National early warning system (NEWS)
FIGURE 1  Linear water production functions for maize subjected to water deficits occurring during the vegetative, flowering, yield formation and ripening periods. The steeper the slope (i.e. the higher the $K_c$ value), the greater the reduction of yield for a given reduction in ET because of water deficits in the specific period.
Percentage of the agriculture areas with VHI below 35

% of **crop area** affected by drought

VHI temporal average value

0-10
10-20
20-25
25-35
>35

\[ wVHI = \sum_{d=1}^{n} k_c \times VHI_d \]
Drought categories

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Drought category</th>
<th>VHI pixel</th>
<th>ASI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exceptional Drought</td>
<td>&lt;35</td>
<td>%</td>
</tr>
<tr>
<td>0.75-0.99</td>
<td>Extreme Drought</td>
<td>36-45</td>
<td>%</td>
</tr>
<tr>
<td>0.50-0.74</td>
<td>Severe Drought</td>
<td>46-55</td>
<td>%</td>
</tr>
<tr>
<td>0.25-0.49</td>
<td>Moderate Drought</td>
<td>56-65</td>
<td>%</td>
</tr>
<tr>
<td>0.01-0.24</td>
<td>Abnormal dry</td>
<td>66-75</td>
<td>%</td>
</tr>
<tr>
<td>0</td>
<td>No Drought</td>
<td>&gt;75</td>
<td>%</td>
</tr>
</tbody>
</table>

* Percentage of pixels in each drought category
Probabilistic forecast of agricultural drought
Probability by administrative unit of having more than 30% of the agricultural area affected by drought during the first crop season.

Hypothetical case of payoff at province level, using the line of 70 and 40% of agricultural area affected by drought in Kenya (1982-2010).
Percentage of area staple crops affected by drought at country level
Trigger for a indexed crop insurances based on geospatial data (1985-2014)

Fuente: INETER, 2017

Estelí, Estelí

40%

Nagarote, León

60%
Historical probability of occurrence of >50% of grain area affected by drought during Primera, Postrera and Apante.

First crop season (Primera)

Second crop season (Postrera)

Third crop season (Apante)

Probability

- < 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- >= 30

- Primera
- Postrera
- Apante
Calibration data for Philippines (raster of the location of rice areas, planting dates and crop coefficient)

Rice Extent map of the Philippines 2000-2012 from MODIS imagery (Oct 2013 version) Sources: IRRI, DA-PhilRice, sarmap, GIZ

Aerobic rice (kc) 0.95 1.00 0.97
ASIS Outputs: Percentage of rice area affected by drought for the first crop season from 1985-1999
Percentage of rice area affected by drought in Philippines

Percentage rice area affected by drought (ASI) during the first crop season

Percentage rice area affected by drought (ASI) during the second crop season

Percentage rice area affected by drought (ASI) during the third crop season

1991

1992

1992
Calibrated ASIS for Bolivia

First rice crop season 2010
First maize crop season 2010
First sorghum crop season 2010
First quinoa crop season 2010
Syria

Crop yield model based on ASI

Figure 1: Wheat yield model in which ASI explains 87% of the yield variation

Figure 2: Barley yield model in which ASI explains 74% of the yield variation
Agroclimatic Information System for supporting decision making

Crop yield

0% Moderate drought index
50% Severe drought index
100% Extreme drought index

Agricultural area affected (ASI)

Planning
- Monitoring
- Forecasting
- Public policy revision
- Investment planning

Early warning - prevention
- Dissemination
- Hazard monitoring and tracking

Contingency plan activation
- Risk reduction actions
- Water storage
- Drought resistant crops
- Short cycle crops

Emergency response
- Catastrophe fund implementation
- Access to contingent credit lines
- Insurance payments
- Livelihoods rehabilitation
GIEWS Earth Observation Website

Thanks

http://www.fao.org/giews/earthobservation/