The MARS, GLOBCAST & GEOGLAM Crop Yield monitoring and Forecasting Systems and their potential Application in Bangladesh

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Slides from: O. Léo (MARS-JRC)
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The MARS Project

- Long-term engagement in crop monitoring in Europe
- On behalf of DG AGRI, implementing legal obligation for Monitoring Agricultural Resources (e.g. REG 78/2008, 1306/2013, Art. 22)
- Analyzing the impact of weather on crop yields as the most important aspect of a varying agricultural production in Europe
- Monthly report on state of crop development in Europe, incl. quantitative forecast of 12 main crops and pasture along the growing season
- Timely dissemination within the Commission (AGRI, Eurostat) and to the public
- Global uptake in news, industry, farm services, international organizations

Article 22

Monitoring of agricultural resources

The measures financed pursuant to point (c) of Article 6 shall aim to give the Commission the means to:

(a) manage Union agricultural markets in a global context;

(b) ensure agri-economic and agri-environmental monitoring of agricultural land, including agro-forestry, and monitoring of the condition of crops so as to enable estimates to be made, in particular as regards yields and agricultural production;

(e) ensure technological follow-up of the agri-meteorological system.
Crop monitoring in Europe
MARS Bulletin Vol. 23 No. 9 (2015)

Little relief for summer crops

Yield forecasts for summer crops at the EU-28 level remain low and are comparable to last month’s forecast. Slight upward revisions are due partly to improved weather conditions in western Europe, and partly to the expected diversion of the most affected grain maize crops to green maize.

In late August, large areas of central and eastern Europe experienced a heat wave and little or no significant rainfall. As most summer crops had already reached maturity in eastern Europe, this latest episode of dry and hot conditions did not have a relevant negative impact, and may even have been beneficial for ripening.

In central European regions, however, where summer crops were still in the grain-filling phase, crop conditions remain critical. The growth of non-irrigated crops in these regions was already stunted due to heat waves in July and early August. Southern Poland and southern Germany were particularly affected. All non-irrigated crops in these regions are in poor condition.

In France, rainfall in late August led to a significant improvement in the conditions of summer crops in western and southern regions, but conditions remain poor in eastern cropland areas.

### Table: Yield (t/ha)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Yield 2014</th>
<th>Yield 2015</th>
<th>%/10/14</th>
<th>%/5/5/5yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL CEREALS</td>
<td>5.74</td>
<td>5.16</td>
<td>-9.6</td>
<td>-1.3</td>
</tr>
<tr>
<td>Total Wheat</td>
<td>5.50</td>
<td>5.57</td>
<td>-5.6</td>
<td>+2.5</td>
</tr>
<tr>
<td>durum wheat</td>
<td>3.30</td>
<td>3.30</td>
<td>-0.3</td>
<td>-1.1</td>
</tr>
<tr>
<td>Total Barley</td>
<td>4.90</td>
<td>4.63</td>
<td>-5.2</td>
<td>+3.1</td>
</tr>
<tr>
<td>spring barley</td>
<td>4.16</td>
<td>3.90</td>
<td>-6.1</td>
<td>-2.3</td>
</tr>
<tr>
<td>winter barley</td>
<td>5.92</td>
<td>5.80</td>
<td>-2.1</td>
<td>+4.5</td>
</tr>
<tr>
<td>Grain maize</td>
<td>8.97</td>
<td>6.43</td>
<td>-29.1</td>
<td>-8.5</td>
</tr>
<tr>
<td>Fy63</td>
<td>4.23</td>
<td>3.72</td>
<td>+12.9</td>
<td>-3.9</td>
</tr>
<tr>
<td>triticale</td>
<td>4.63</td>
<td>4.09</td>
<td>-9.7</td>
<td>-18.0</td>
</tr>
<tr>
<td>Other cereals</td>
<td>3.14</td>
<td>2.87</td>
<td>-8.6</td>
<td>-16.0</td>
</tr>
<tr>
<td>rape and canola</td>
<td>2.32</td>
<td>3.25</td>
<td>-31.3</td>
<td>+3.8</td>
</tr>
<tr>
<td>Olotes</td>
<td>32.95</td>
<td>31.62</td>
<td>-8.5</td>
<td>+2.6</td>
</tr>
<tr>
<td>Sugar beets</td>
<td>77.00</td>
<td>70.34</td>
<td>-8.6</td>
<td>+2.1</td>
</tr>
<tr>
<td>Sunflower</td>
<td>2.15</td>
<td>1.87</td>
<td>-12.9</td>
<td>-7.5</td>
</tr>
</tbody>
</table>

Content:
1. Agro-meteorological overview
2. Observed canopy conditions by remote sensing
3. Country analysis
4. Crop yield forecasts
5. Pest and disease
6. Atlas

Online version
Issued: 21 September 2015

European Commission
• ICT-based sophisticated system tailored to support yield forecasting
• Based on four pillars: agro-meteorology, crop growth modelling, remote sensing, agricultural statistics
• Near-real time context: dataflow, data processing, analysis, bulletin production
• Constantly innovation and refinement ongoing to keep the system updated and at the state-of-the-art
• Key is the analyst and the expert knowledge available
• Current accuracy: < 5% overall yield estimates in EU
• Resources: team of analysts and project management at JRC, in-house ICT support, outsourced model infrastructure and technical routine work (MARSOP consortium)
• Scientific networking with universities, research institutions, national ministries, regional offices, etc. throughout Europe
MARS Crop Yield Forecasting System

Common spatial framework
CGMS database

Weather monitoring
MARS DB

Crop growth simulation
CGMS / BioMA

Statistical yield forecasting
CoBo

Vegetation monitoring
Remote sensing

Production of daily meteorological indicators
Production of 10-day biophysical indicators

Site and crop specific information to tailor the system to the area/crop of interest

Time series of crop specific area/yield statistics

Operational data processing by ALTERRA, VITO and METEOCONSULT

Expert judgement and decisions required

Quantitative analysis
Crop yield forecast

Toolboxes and software
CGMS / BioMA
MARS viewer
SPIRITS
ControlBoard (CoBo)
1.4 Weather forecast for the coming days (18 – 25 September)

Warmer-than-usual weather is foreseen for the central and eastern Mediterranean region, eastern Europe and Turkey. Cooler-than-usual conditions will dominate in western Europe. Although some (mostly minor to moderate) rainfall episodes are expected in most of Europe, dry conditions will prevail over the Iberian Peninsula, the Mediterranean and eastern Europe.

The expected synoptic situation will divide Europe into two main sectors: a) central and eastern Europe with mild and dry conditions and b) western, northern and central European areas with cooler and wetter conditions.
Cumulated fAPAR comparison

Current year - Medium term average (MTA / 2007-2014)
Considered period: 1 August 2015 - 10 September 2015

Relative differences (%) compared to MTA

- ≤ 50
- ≥ 25
- ≥ 5
- ±
- ≤ -5
- ≤ -25
- ≤ -50
- No / less relevant arable land

Mask: Arable land mask based on CLC 2000
Data source: MARS remote sensing database / METOP - AVHRR

RELATIVE SOIL MOISTURE
GRAIN MAIZE
Averaged values
from: 01 September 2015
to: 20 September 2015
Deviation:
Year of interest: LTA

CROP DEVELOPMENT
GRAIN MAIZE
resolution: 25x25 km
from: 01 September 2015
to: 10 September 2015
Year of interest: LTA

17/09/2015
resolution: 25x25 km

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Source: Joint Research Centre
Italy

Recent rains only partially improved summer crop conditions. After the dry and warm period from June to August, beneficial rainfall partially compensated for the slight drought, allowing for some improvement in crops, the yield forecasts are still far below last year's record level.

In Italy, weather conditions were among the warmest and driest for the country, with temperatures well above seasonal values. Although normal from the second half of the period from 1 August to the end of September, the usual by about 1°C. Conditions are still not ideal for many crops.
GLOBCAST Project

- South America (Brazil, Argentina)
- EU Mediterranean Neighborhood
- Eastern Europe & Neighborhood
- Asia (China, India)

North America (USA, Canada)

Australia
Recommended realization of a regional system
MARS crop monitoring eastern European neighbourhood
covering Turkey, Ukraine, Belarus, European Russia and Kazakhstan

Crop monitoring in Argentina
Update report for wheat
Period covered: 01 July – 10 December 2014

MARS Crop monitoring in China
Update report on wheat, maize and rice
Period observed: 1 September 2014 – 20 July 2015
Positive outlook for winter wheat

Seasonal highlights
- The El Nino Southern Oscillation impacted rainfall distribution. Southern China experienced exceptional rainfall in May while northeast China entered a dry period in July.
- Winter wheat benefitted from a mild winter, followed by a rainy spring and good harvesting conditions.
- Dry conditions in North China Plan foreseen to impact maize production but the national production remains high.
- Exceptional rainfall in the south and on the reaches of the Yangtze ensure sufficient irrigation water for paddy rice.

Crop yield forecasts

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area x 1000 ha</th>
<th>Yield t/ha</th>
<th>Production x 1000 t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter wheat</td>
<td>5.32</td>
<td>5.53</td>
<td>5.63</td>
</tr>
<tr>
<td>Spring wheat</td>
<td>1.94</td>
<td>2.82</td>
<td>1.89</td>
</tr>
<tr>
<td>Total wheat</td>
<td>7.26</td>
<td>8.34</td>
<td>7.52</td>
</tr>
<tr>
<td>Early rice</td>
<td>5.95</td>
<td>5.93</td>
<td>5.80</td>
</tr>
<tr>
<td>Middle rice</td>
<td>10.72</td>
<td>7.20</td>
<td>7.17</td>
</tr>
</tbody>
</table>

Crop yield forecasts at country level

- Wet conditions in southern regions could compromise the positive wheat outlook.
- Persistent dry conditions did not significantly affect overall summer crops production.
- General increase of crops yields in the most developed agricultural regions.
- Significant increase of soybean production increase.
- Very positive expectations for wheat yields.
- Low yields expected for the less producing areas of North region.
National production and balance

China
- 1st producer of rice and wheat
- 2nd producer of maize

India
- 2nd producer of rice
- 2nd producer of wheat

China: Imports increasing (quality grains and lower price of imports)

India: Increasing exports of rice and wheat

Source: FAOSTAT

Source: USDA
Crop monitoring in India
Update report for wheat and Rabi rice
Period observed: 22 November 2014 – 22 April 2015
Concerns for wheat harvest

Crop monitoring in China
Update report on wheat
Period observed: 22 September 2014 – 30 April 2015
Towards a record production of winter wheat

MARS Crop monitoring in China
Update report on wheat, maize and rice
Period observed: 1 September 2014 – 20 July 2015
Positive outlook for winter wheat

Full bulletin to be delivered Oct/2015
- China
- India
China (Maize and E. Rice)

Yield forecast

- Below average rainfall in the north of China
- Heavy rainfall during harvest of early rice

### Area x 1000 ha vs. Yield t/ha vs. Production x 1000 t.

<table>
<thead>
<tr>
<th>Area (China)</th>
<th>2015</th>
<th>MARS 2015 forecasts</th>
<th>Avg 5 yrs</th>
<th>Diff % 2015/5yrs</th>
<th>2015 Avg 5 yrs</th>
<th>Diff % 2015/5yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>37,809.40</td>
<td>5.81</td>
<td>5.76</td>
<td>0.83</td>
<td>219,541.62</td>
<td>200,886.76</td>
</tr>
<tr>
<td>Henan</td>
<td>3,335.53</td>
<td>5.80</td>
<td>5.60</td>
<td>3.49</td>
<td>19,342.75</td>
<td>17,419.80</td>
</tr>
<tr>
<td>Shandong</td>
<td>3,187.05</td>
<td>6.18</td>
<td>6.55</td>
<td>-5.54</td>
<td>19,705.50</td>
<td>19,839.73</td>
</tr>
<tr>
<td>Hebei</td>
<td>3,237.24</td>
<td>5.15</td>
<td>5.31</td>
<td>-3.07</td>
<td>16,671.76</td>
<td>16,338.77</td>
</tr>
<tr>
<td>Anhui</td>
<td>879.99</td>
<td>4.68</td>
<td>4.68</td>
<td>-0.08</td>
<td>4,117.45</td>
<td>3,849.36</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>958.81</td>
<td>7.19</td>
<td>6.95</td>
<td>3.45</td>
<td>6,894.81</td>
<td>5,697.43</td>
</tr>
<tr>
<td>Hubei</td>
<td>597.17</td>
<td>4.94</td>
<td>4.85</td>
<td>1.89</td>
<td>2,951.23</td>
<td>2,748.62</td>
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<tr>
<td>Shanxi</td>
<td>1,738.94</td>
<td>5.08</td>
<td>5.29</td>
<td>-3.94</td>
<td>8,837.28</td>
<td>8,718.03</td>
</tr>
<tr>
<td>Yunnan</td>
<td>1,567.23</td>
<td>4.63</td>
<td>4.55</td>
<td>1.96</td>
<td>7,262.55</td>
<td>6,658.90</td>
</tr>
<tr>
<td>Guizhou</td>
<td>810.53</td>
<td>5.12</td>
<td>4.21</td>
<td>21.47</td>
<td>4,146.68</td>
<td>3,299.51</td>
</tr>
<tr>
<td>Chongqing</td>
<td>485.97</td>
<td>5.43</td>
<td>5.48</td>
<td>-0.90</td>
<td>2,639.76</td>
<td>2,565.75</td>
</tr>
<tr>
<td>Guangxi</td>
<td>611.86</td>
<td>4.26</td>
<td>4.26</td>
<td>-0.14</td>
<td>2,605.90</td>
<td>2,450.06</td>
</tr>
<tr>
<td>Inner Mongolia</td>
<td>3,301.48</td>
<td>6.37</td>
<td>6.19</td>
<td>2.83</td>
<td>21,020.54</td>
<td>17,827.73</td>
</tr>
<tr>
<td>Liaoning</td>
<td>2,338.30</td>
<td>6.03</td>
<td>6.27</td>
<td>-3.85</td>
<td>14,099.94</td>
<td>13,762.91</td>
</tr>
<tr>
<td>Jilin</td>
<td>3,643.54</td>
<td>7.63</td>
<td>7.42</td>
<td>2.83</td>
<td>27,789.30</td>
<td>24,530.98</td>
</tr>
<tr>
<td>Heilongjiang</td>
<td>5,672.37</td>
<td>5.84</td>
<td>5.63</td>
<td>3.74</td>
<td>33,109.64</td>
<td>28,306.36</td>
</tr>
<tr>
<td>Others</td>
<td>1,333.78</td>
<td>5.79</td>
<td>5.78</td>
<td>0.12</td>
<td>7,716.18</td>
<td>7,103.44</td>
</tr>
</tbody>
</table>

### Production x 1000 t.

- Heavy rainfall during harvest of early rice

<table>
<thead>
<tr>
<th>Area (China)</th>
<th>Yield t/ha</th>
<th>Production x 1000 t.</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>5.72</td>
<td>33,201.29</td>
</tr>
<tr>
<td>Henan</td>
<td>5.39</td>
<td>1,269.82</td>
</tr>
<tr>
<td>Shandong</td>
<td>5.00</td>
<td>632.82</td>
</tr>
<tr>
<td>Hebei</td>
<td>5.77</td>
<td>8,341.67</td>
</tr>
<tr>
<td>Anhui</td>
<td>5.39</td>
<td>1,269.82</td>
</tr>
<tr>
<td>Xinjiang</td>
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<td>8,092.68</td>
</tr>
<tr>
<td>Hubei</td>
<td>5.74</td>
<td>2,212.57</td>
</tr>
<tr>
<td>Guangxi</td>
<td>5.79</td>
<td>8,092.68</td>
</tr>
<tr>
<td>Hunan</td>
<td>5.77</td>
<td>8,341.67</td>
</tr>
<tr>
<td>Jiangxi</td>
<td>5.79</td>
<td>8,092.68</td>
</tr>
<tr>
<td>Fujian</td>
<td>5.94</td>
<td>1,164.05</td>
</tr>
<tr>
<td>Guangdong</td>
<td>5.56</td>
<td>5,050.32</td>
</tr>
<tr>
<td>Hainan</td>
<td>5.33</td>
<td>772.32</td>
</tr>
<tr>
<td>Others</td>
<td>5.96</td>
<td>285.72</td>
</tr>
</tbody>
</table>
Intense rainfall in March and April coincided with harvesting of wheat in northwestern states (most important producing areas for wheat).
Reliability of the crop model (China)

- Errors are increasing depending on meteorological data and crop calibration
- Improving meteorological data will improve crop model calibration and forecast reliability
Initial GEO Agricultural Monitoring Workshop
July 2007, UN-FAO

- IGOL*/GEO AgMon Workshop to develop a strategy for global agricultural monitoring in the framework of GEO
  - Attendance: 25 national and international organizations
  - Establishment of the ‘GEO/IGOL Agricultural Monitoring Community of Practice’

- Agricultural Monitoring Community: many common issues of data frequency, timeliness, policy, availability and continuity

- Agricultural Monitoring Research Community: little that could be adopted as ‘operational’
  - Reviewed the current state of agricultural monitoring, identified gaps and developed a set of priorities and recommendations

Source: C. Justice

IGOL*: Integrated Global Observation of Land, a GEO programme
Recent volatility of Agricultural Prices

Monthly Wheat Prices 1960-2011 ($/Metric Ton)

Source: World Bank

Nominal wheat price in US $/metric Ton

2008 Price hikes
Droughts: Australia & Ukraine

2010/11 Price hikes
Drought: Russia

Average Price 1972-2007: 150$

Average Price 2008-2012: 300$

Becker-Reshef et al., UMD
GEOGLAM Objectives

- To strengthen the international community’s capacity to produce & disseminate relevant, timely and accurate information and forecasts on agricultural production at national, regional and global scales, through reinforced use of Earth Observations

GEOGLAM is a « coordination programme », aiming at
- supporting, strengthening and articulating existing efforts
- developing capacities and awareness at national and global level
- disseminating information
GEOGLAM Component Structure

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>International/Global</td>
<td>National / Subnational</td>
<td>Food Insecure and Most Vulnerable</td>
</tr>
</tbody>
</table>

- 4. EO Data Acquisition & Dissemination Coordination
- 5. Research & Development toward Operations
- 6. Capacity Development for EO
GEOGLAM Actors
GEOGLAM Community of Practice

Open Community made up of international and national agencies concerned with agricultural monitoring including Ministries of Ag, Space agencies, Universities, & Industry
Crop conditions in AMIS countries (as of April 28th)

Crop condition map synthesizing information for all four AMIS crops as of April 28th. Crop conditions over the main growing areas for wheat, maize, rice, and soybean are based on a combination of national and regional crop analyst inputs along with earth observation data. Crops that are in other than favourable conditions are displayed on the map with their crop symbol.
Crop Monitor website for additional information

www.cropmonitor.org

Contact: Inbal Becker-Reshef: ireshef@umd.edu
Feasible in Bangladesh?

- YES of course, but at the condition of:
  - Fixing objectives and priorities
  - Building staff competences (training)
  - Building infrastructure (Internet, Hardware, software)
  - Sticking to existing methodologies
  - Merging international databases with national data
  - Giving time to time