International Meeting on Food Security, Earth Observations and Agricultural Monitoring

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Agriculture Monitoring: African Perspective

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RCMRD, Nairobi-Kenya
I. About RCMRD:

- Is Intergovernmental Organization
- Established in 1975, in Nairobi Kenya by five founding countries
- Currently has 20 member States
Major Activities of RCMRD

A. Advisory services

B. Training

C. Project implementation

D. Research and Development

E. Data and information Dissemination

F. Disaster Early Warning

G. Servicing and Calibration of Mapping Equipment
II. Agricultural Mapping and Monitoring in Africa

• Issues of Concerns as Compared to other Regions
  – Agricultural Statistics in Africa
    • Not up-to-date and not good enough for decision making for food security
    • Expensive exercise to undertake in a regular manner
      – List-frame surveys based
      – Vast land mass to cover
      – Area frame survey is not being used operationally
      – No data and expertise
  – Crop Acreage and Mapping
    • Land parcels are fragmented and too small
    • Cropping pattern
      – Mixed Cropping, difficult for aerial survey as well
III. Current Efforts and Initiatives in Agricultural Mapping and Monitoring in Africa

• Arable Land identification and Mapping
  – Detailed land use and land cover Mapping and assessment
  – Land use planning
  – Land suitability analysis analysis and mapping

• Monitoring of plant health and growth
  – Plant nutrition monitoring
  – Plant health monitoring
    • Viral diseases
    • Pest infestation and control

• Yield estimation and forecast
  – Crop acreage mapping
  – Yield estimation
Initiatives for Building on Capacity for African Agricultural Monitoring in Africa

• Research projects in Crop Modeling
  – SERVIR (NASA JPL Team, FEWSNet)
    – Sites in Kenya and Tanzania
  – FEWSNet activities
    – In Most of African Countries
  – FP7 Projects (GMFS, AFRICAB, SIGMA,..)
    – Ethiopia, Sudan, Malawi, Kenya, Mozambique
  – JRC -MARS activities
A. RAPID Cropped Area Assessment using Satellite image (Naivasha area, Kenya), RLCM

Two Classes:
- Cropped
- Non Cropped
Cropped area in Raster format for Naivasha
High Resolution Satellite images of Lake Naivasha, Kenya for land use and crop area change

Jan, 1986
Landsat-TM

Feb. 2009
(ASTER)
Multi-temporal land use mapping using RLCM
B. Cropped Area and Crop-type Mapping
GMFS Approach
<table>
<thead>
<tr>
<th></th>
<th><strong>Multi-temporal</strong></th>
<th><strong>Single-date</strong></th>
<th><strong>Multi-temporal</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENVISAT ASAR or</td>
<td>Landsat TM-5 or</td>
<td>ENVISAT ASAR and/or</td>
</tr>
<tr>
<td></td>
<td>ALOS PALSAR-1 or</td>
<td>SPOT-4/5</td>
<td>Cosmo-SkyMed SS</td>
</tr>
<tr>
<td></td>
<td>Radarsat-2 or</td>
<td></td>
<td>and/or</td>
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<tr>
<td></td>
<td>Interferometric</td>
<td></td>
<td>TerraSAR-X SS and/or</td>
</tr>
<tr>
<td></td>
<td>Cosmo-SkyMed StripMap or</td>
<td></td>
<td>and/or</td>
</tr>
<tr>
<td></td>
<td>RapidEye or</td>
<td></td>
<td>Radarsat-2 and/or</td>
</tr>
<tr>
<td></td>
<td>Ikonos or</td>
<td></td>
<td>RapidEye</td>
</tr>
<tr>
<td></td>
<td>QuickBird</td>
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</table>

<table>
<thead>
<tr>
<th>Potential crop extent prior to the start of crop season</th>
<th>PotCropExt once every n years</th>
<th>PCA-SoS once every m years</th>
<th>CropGrowthExt every crop season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential cultivated area at start of crop season</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop growth extent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Cultivated Area* = *PotCropExt* ∩ *PCA-SoS* ∩ *CropGrowthExt*
Cultivated Area (Acerage)

Polygons in green areas represent the cultivated areas.
Malawi Cultivated Area validation

Field work:

Sampling units: predefined POINTS
Systematic grid: representative and well distributed samples for any kind of application
Clustering: reduced travelling time and costs
Malawi 2010/11 – Lilongwe

Field work performed by MoAFS and EFTAS

<table>
<thead>
<tr>
<th></th>
<th>Other</th>
<th>Crop</th>
<th>Total</th>
<th>Omission error (%)</th>
<th>Commission error (%)</th>
</tr>
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<tbody>
<tr>
<td>Other - A</td>
<td>32</td>
<td>0</td>
<td>32</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Crop - B1-6</td>
<td>8</td>
<td>94</td>
<td>102</td>
<td>8</td>
<td>1</td>
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<tr>
<td>Other - B7</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other - C</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other - D</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other - E</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other - F</td>
<td>15</td>
<td>1</td>
<td>16</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Other - G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other - H</td>
<td>13</td>
<td>0</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>76</td>
<td>95</td>
<td>171</td>
<td><strong>K-coeff 0.9</strong></td>
<td><strong>Overall accuracy 95%</strong></td>
</tr>
</tbody>
</table>


C. Crop Yield Forecasting System from GMFS and MARS

Statistical infrastructure
- time series regression, similarity analyses

Remote Sensing infrastructure
- Vegetation state & meteo indicators since 1981 Europe, 1998 worldwide

Crop Model infrastructure
- Agrometeo indicators derived from crop growth model – WOFOST / LINGRA / WARM and GWSI

Meteorological infrastructure
- observed data since 1975 Europe under construction for Africa worldwide ECMWF data + archive
Crop Monitoring and Yield forecast Systems

MARS Crop Growth Monitoring and Yield forecast Systems (CGMYS)

- Remote sensing
  - Pixels 0.3 - 1 - 5Km
- Ground Stations + ECMWF 50/25/10km grids
- CGMS Grids 50/25Km
- METEO LEVEL 1
- SOIL+LC LEVEL 0
- QUALITATIVE INFO / EWS
  - Near real-time Crop monitoring
- QUANTITATIVE INFO
  - Yield forecast

- Crop models
- Administrative Units

- Cropping models
- Grids 50/25Km
- STAT LEVEL 3
- CGMS LEVEL 2
- METEO LEVEL 1
- SOIL+LC LEVEL 0

<table>
<thead>
<tr>
<th>CROPS</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
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<tbody>
<tr>
<td>Wheat</td>
<td>1.7</td>
<td>1.6</td>
<td>1.5</td>
<td>1.4</td>
<td>1.3</td>
<td>1.2</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Rice</td>
<td>2.5</td>
<td>2.3</td>
<td>2.1</td>
<td>1.9</td>
<td>1.8</td>
<td>1.6</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Maize</td>
<td>6.5</td>
<td>6.3</td>
<td>6.1</td>
<td>5.9</td>
<td>5.7</td>
<td>5.5</td>
<td>5.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Corn</td>
<td>25</td>
<td>24</td>
<td>23</td>
<td>22</td>
<td>21</td>
<td>20</td>
<td>19</td>
<td>18</td>
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<tr>
<td>Barley</td>
<td>10.1</td>
<td>10.0</td>
<td>9.9</td>
<td>9.8</td>
<td>9.7</td>
<td>9.6</td>
<td>9.5</td>
<td>9.4</td>
</tr>
<tr>
<td>Rice</td>
<td>1.1</td>
<td>1.0</td>
<td>0.9</td>
<td>0.8</td>
<td>0.7</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
</tr>
</tbody>
</table>
Examples of FOOD SEC bulletins from JRC-MARS

Crop yield forecast in the Horn of AFRICA

In general, the climate conditions were favorable for mean and many crops in June and July. In the last few years, drought and water shortages have been important limiting factors for crop growth in many regions. The results of the climate stand indicate that the forecasted moisture conditions are generally better than last year, but still below normal in some parts of the Horn of Africa.

The 2009 'Long rain' Maize Production in Kenya is estimated at 1.8 Million MT. Food and Feed production for Kenya, Tanzania, and Uganda is estimated at 1.8 million MT. The main constraints for maize production in these countries are water availability and pests.

Near normal start of the first crop

In general, the climate conditions were favorable for mean and many crops in June and July. In the last few years, drought and water shortages have been important limiting factors for crop growth in many regions. The results of the climate stand indicate that the forecasted moisture conditions are generally better than last year, but still below normal in some parts of the Horn of Africa.

First half of rice growing season 2008 seems slightly better or close to normal

Famine in June and August 2000 and extremely high temperatures have created suitable conditions for rice development in all provinces of DPRK. In a report, the delays in rice development which was scheduled from May to July 2000 is due to late planting of rice. However, the increase in July and August may have caused rice flooding in some southern regions.
Quantitative yield forecasts (GMFS)

Statistical models combining best predictors from EO (NDVI, LAI, DMP) or Agromet model and trend.

KENYA

Estimation of the National maize production during the "Long rain" crop season 2009 and comparison with the FOOD SEC 2008 estimates.

<table>
<thead>
<tr>
<th>Province</th>
<th>Estimated yield 2009</th>
<th>Wf*</th>
<th>Estimated maize area 2009</th>
<th>Maize production 09 MT</th>
<th>Maize production 08 MT</th>
<th>Variation % (2009 vs 2008)</th>
<th>Absolute difference MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td>1.60</td>
<td>0.07</td>
<td>84,890</td>
<td>136,129</td>
<td>134,312</td>
<td>1</td>
<td>1,817</td>
</tr>
<tr>
<td>Coast</td>
<td>0.71</td>
<td>0.04</td>
<td>48,508</td>
<td>34,348</td>
<td>49,975</td>
<td>-31</td>
<td>-15,627</td>
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<tr>
<td>Eastern</td>
<td>0.11</td>
<td>0.18</td>
<td>218,287</td>
<td>24,072</td>
<td>114,365</td>
<td>-79</td>
<td>-90,293</td>
</tr>
<tr>
<td>Nyanza</td>
<td>1.61</td>
<td>0.13</td>
<td>157,652</td>
<td>254,402</td>
<td>252,361</td>
<td>1</td>
<td>2,041</td>
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<tr>
<td>Rift Valley</td>
<td>1.80</td>
<td>0.43</td>
<td>521,465</td>
<td>939,715</td>
<td>1,085,765</td>
<td>-13</td>
<td>-146,050</td>
</tr>
<tr>
<td>Western</td>
<td>2.39</td>
<td>0.15</td>
<td>181,906</td>
<td>435,431</td>
<td>418,706</td>
<td>4</td>
<td>16,725</td>
</tr>
<tr>
<td>National</td>
<td>1.50</td>
<td></td>
<td>1,212,708</td>
<td>1,824,097</td>
<td>2,335,886</td>
<td>-22</td>
<td>-511,789</td>
</tr>
</tbody>
</table>
IV. National Scale Land Use Land Cover Mapping (Crop land is one of the classes)

Countries participating in the project
1. Malawi
2. Rwanda
3. Tanzania
4. Zambia
5. Namibia
6. Botswana
V. Land suitability determination (Physical Planning)
Proposed Land use Plan

THE INTEGRATED PLAN

THE NYIKA PLATEAU (LIVESTOCK PROMOTION ZONE)
1. Promote Livestock production and Marketing
2. Promotion of the exploitation of earth resources
3. Enhance trade and commerce
4. Improve Access to Infrastructure and Services

THE FOOT PLATEAU AND THE COASTAL UPLANDS (AGRICULTURE PROMOTION ZONE)
1. Enhance food security systems
2. Improve extension delivery systems
3. Improve Access to Infrastructure and Services
4. Conservation and sustainable use of natural resources
5. Adopt a hierarchy of urban centres as basis for service provision
6. Protect and manage water resources
7. Institute Disaster preparedness and prevention programmes
8. Promote agro-based industries

THE COASTAL PLAIN OR CORAL RAG - THE TURISIM PROMOTION ZONE (AREA)
1. Infrastructure Development and Improvement
2. Sustainable use and Conservation of the Marine Resources
3. Sustainable Land use planning
4. Promotion of Indigenous Culture
5. Diversification of sources of employment and income generating opportunities
6. Use land resources efficiently by making fuller use of existing urban land to support additional residential development within existing urban areas
7. Manage urban growth to limit urban sprawl through a development staging strategy and other complementary techniques
8. Optimal utilization of E. E. Z.
VI. GEOGLAM and Africa

• Africa is given less priority (Observation)
  – Despite food security issue and dynamic land use and land cover changes,
  – Despite complex factors affecting Satellite based agricultural Monitoring,
  – Despite lack of data (Satellite and in-situ) and knowledge
  – Governments are ready to embark on improving Ag. Monitoring in Africa
• JECAM Goal: to develop best practices guidelines through a network of study sites representative of many of the world’s cropping systems
  – Support monitoring enhancements within operational agricultural monitoring systems
• JECAM Program Office is coordinated by AAFC, Canada and UCL

15 sites currently exist, at least 5 new in development
VI. Conclusion

- Need to establish more JECAM Sites in Africa

- Build capacity of African institutions so that there is a uniform and comparable Agricultural information

- Continue working with Regional and national institutions

- Need to bring together Statistics and Agriculture Sectors together

- National mapping institutions can play important role
Thank you very much!
Merci Beacoup!

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