Remote Sensing application for agricultural monitoring
(Case studies: national assessments)

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This presentation has been developed in collaboration with:
Trade and Markets Division (EST)
Statistics Division (ESS)
Climate, Energy and Tenure Division (NRC)

FAO is the United Nations agency responsible for collecting,
analyzing, interpreting and disseminating information relating to
food, nutrition, agriculture and related subjects

FAO priorities
 improving agricultural production in poor rural communities;
 developing and conserving natural resources;
 expanding rural infrastructure and market access;
 strengthening capacity for knowledge generation exchange;
 ensuring access to food for the neediest.

Utilization of Ancillary data (including the integral use of
Remotely Sensed data) is a key component of FAO
Monitoring of Agricultural Production

<table>
<thead>
<tr>
<th>Region</th>
<th>Prime land</th>
<th>Good land</th>
<th>Marginal land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed</td>
<td>590</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>Developing</td>
<td>969</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>World Total</td>
<td>1559</td>
<td>28</td>
<td>19</td>
</tr>
</tbody>
</table>

Net changes in major land use (million ha)

<table>
<thead>
<tr>
<th>Region</th>
<th>1961</th>
<th>2009</th>
<th>Net increase 1961-2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated land</td>
<td>1,368</td>
<td>1,527</td>
<td>12%</td>
</tr>
<tr>
<td>Rain-fed</td>
<td>1,229</td>
<td>1,226</td>
<td>0.2%</td>
</tr>
<tr>
<td>Irrigated</td>
<td>159</td>
<td>301</td>
<td>117%</td>
</tr>
</tbody>
</table>

Countries vulnerable to food insecurity

Where the rural poor are concentrated
GAEZ Initiative
- For assessing agricultural resources and potential
- Developed by FAO and IIASA
- Five major thematic areas:
  - Land and water resources,
  - Agro-climatic resources,
  - Suitability and potential yields, actual yields
  - Area harvested and production,
  - Yield and production gaps
- 280 crops and crop groups, water supply, inputs, time period historical 1961-1990, "current" - 2000 and future, 2020s, 2050s, 2080s - data will be progressively updated.
- More than 24 TB of data and information

Applications of Remote Sensing
Coarse resolution satellite imagery:
1. Monitor the state of vegetation (NDVI) in cultivated and rangeland areas
2. Monitor the rainy season and identify areas which are likely to have suffered from or might be affected by, drought or excessive rainfall.
Medium/High resolution satellite imagery:
1. Estimate/Forecast yields of major crops
2. Estimate the extent of cultivated land

Agricultural Monitoring, Remote Sensing and FAO
- Long history in FAO;
- EO data used to monitor the cropping season in some priority areas/countries. Not a routine activity for all areas.
- Analysis is at HQ; Regional Offices and local levels - especially in member countries: National Capacity development is a fundamental part of building sustainable monitoring systems

Global Precipitation Indices for Agriculture
- Agriculturally relevant precipitation indices: deviation from normal, water stress, agriculture season length, etc.;
- Provide continuous information on value added variables relevant to decision making at the regional and national level
- Provide information on progress of the precipitation indices from the past to current

Agricultural Stress Index (ASI): in progress
- Objectives
  To provide GIEWS with crop and vegetation monitoring tools for fulfilling the early warning activities based on the real-time remote sensing information
- The system proposed will guarantee independence and autonomy of analysis in data acquisition
- Main characteristics of the ASI system
  - ASI will run automatically at GLOBAL level using the METOP remote sensing imagery free of charge (1 km resolution)
  - The vegetation index will be integrated temporal and spatial in the agricultural areas
  - Final output will be GLOBAL quick look maps (every 10 days) showing the hot spots of agricultural areas probably affected by drought
- Developed in collaboration with VITO and EU-JRC

GIEWS Initiative and Products
- Cereal production forecasts and vegetation conditions, both to monitor crop conditions and pasture, especially in sub-Saharan Africa countries, are substantiated with analysis based on Remote Sensed data (RFE, NDVI...).
- Crop Prospects and Food Situation
- Food Outlook
- On-line Country Briefs
- Special Reports and Alerts
NDVI and RFE analysis was important for identification of areas at risk from drought. It helps prioritize field trips and improve estimates of production in areas that could not be visited.

Key variables/information for crop monitoring & production forecasting:
- Input availability
- Planted areas
- Pests and diseases
- Policies
- Meteorological data
- Crop condition

Enhancing National Capacity for Agricultural Monitoring:
- Requirements at country level:
  - Up-to-date land cover and especially cropland area mapping is fundamental on a regular basis
  - Robust area frame sampling design, refined with land cover as a basis for stratification and sample allocation
  - Improved rainfall estimation and soil moisture conditions need to be tested and made operationally available
  - Improved estimation of area planted seasonally and field validated needs to become a regular product of our community
- Policies
- Meteorological data
- Crop condition

Supported by FAO’s Natural Resources and Environment Department

The momentum has recently been created to align requirements and initiatives with GEOGLAM and to coalesce efforts and reinforce partnerships, in this regard we see the GEO GLAM initiative as assisting FAO and others, in their endeavors to improve estimates and forecasts.

HOW TO SCALE UP?: A community of practitioners, working in partnership, can be more successful if this is tackled collectively.

National land cover mapping:
- Standardized and harmonized land cover baseline: built on international standards - LCCS
- Updated databases are an important component of many environmental applications but also for:
  - National agricultural analysis
  - Natural Resources monitoring
  - Strengthening National Capacity for Agricultural Monitoring

National land cover mapping: Ethiopia case study:
- Land cover in agricultural areas using high resolution data, standard procedures and methodologies, and using the FAO Land Cover Classification System (LCCS).
- Sampling design and area frame analysis greatly improved
- More accurate agricultural statistics

Example of photo-key
Pakistan’s Crop Monitoring System

On going project on the improvement of national and provincial capacity to collect and analyze agricultural information and deliver accurate, reliable, timely, precise and cost effective agricultural statistics.

This will be obtained through the:

- integration of remotely sensed data into existing data collection, analysis, and dissemination systems;
- design and implementation of rigorous agriculture and rural survey methods (e.g. area frame and crop yield models);
- promotion of cooperative use and sharing of field data;
- improvement of quality and outlook of current crop forecast/estimation bulletins;
- development of human resources and technical capacities.

Pakistan System: Model

- Satellite based vegetation analysis
- Weather impacts on crop
- Crop yield estimation
- Fertilizer availability
- Irrigation water availability
- Crop yield forecasts

Area Frame and Sampling

Area Frame System

Crop Estimates 2010-11 (SUPARCO & CRS)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Punjab</th>
<th>Sindh</th>
<th>Khyber Pakhtunkhwa</th>
<th>Balochistan</th>
<th>National</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat Area</td>
<td>6695.0</td>
<td>6690.5</td>
<td>1509.0</td>
<td>1144.4</td>
<td>724.5</td>
</tr>
<tr>
<td>Wheat Yield</td>
<td>2764.0</td>
<td>2845.0</td>
<td>2585.0</td>
<td>3746.9</td>
<td>2015.0</td>
</tr>
<tr>
<td>Wheat Prod</td>
<td>18505.0</td>
<td>19041.0</td>
<td>3900.8</td>
<td>4287.9</td>
<td>24306.1</td>
</tr>
<tr>
<td>Cotton Area</td>
<td>2052.7</td>
<td>2200.6</td>
<td>605.4</td>
<td>457.6</td>
<td>2690.6</td>
</tr>
<tr>
<td>Cotton Yield</td>
<td>633.0</td>
<td>606.7</td>
<td>707.0</td>
<td>1316.0</td>
<td>648.0</td>
</tr>
<tr>
<td>Cotton Prod</td>
<td>7643.1</td>
<td>7854.0</td>
<td>2516.1</td>
<td>3536.8</td>
<td>10259.1</td>
</tr>
<tr>
<td>Sugarcane Yield</td>
<td>55.4</td>
<td>55.8</td>
<td>56.0</td>
<td>560.8</td>
<td>54.6</td>
</tr>
<tr>
<td>Sugarcane Prod</td>
<td>48386.3</td>
<td>37481.0</td>
<td>16475.2</td>
<td>13766.4</td>
<td>69860.5</td>
</tr>
<tr>
<td>Rice Area</td>
<td>1901.2</td>
<td>1766.8</td>
<td>371.8</td>
<td>361.2</td>
<td>2401.5</td>
</tr>
<tr>
<td>Rice Yield</td>
<td>1965.0</td>
<td>1916.0</td>
<td>3445.0</td>
<td>3406.2</td>
<td>2236.0</td>
</tr>
<tr>
<td>Rice Prod</td>
<td>3735.8</td>
<td>3384.0</td>
<td>1281.0</td>
<td>1230.3</td>
<td>5370.7</td>
</tr>
</tbody>
</table>

SUPARCO: Pakistan Space & Upper Atmosphere Research Commission
CRS: Crop Reporting Services

Annual Costs of Crop Monitoring

<table>
<thead>
<tr>
<th>Source</th>
<th>Cost per year (in million US Dollar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punjab</td>
<td>$2.2M</td>
</tr>
<tr>
<td>Sindh</td>
<td>$0.7M</td>
</tr>
<tr>
<td>Baluchistan</td>
<td>$0.8M</td>
</tr>
<tr>
<td>Khyber Pakhtunkhwa</td>
<td>$0.7M</td>
</tr>
<tr>
<td>Total</td>
<td>$4.4M</td>
</tr>
<tr>
<td>Agriculture prog , SUPARCO*</td>
<td>$0.1M</td>
</tr>
</tbody>
</table>

Note: The current cost of satellite imagery is $0.1M. Usually 104 SPOT 5 scenes are required to cover the total agriculture area of Pakistan. Agriculture area is covered twice (once for each cropping season).
Rapid Crop Damage Assessment

- Monthly bulletins issued by SUPARCO and FAO in collaboration

FAO fosters use of medium and high resolution EO observation agricultural monitoring and technology combined with in-situ observation to provide reliable information as decision support products

FAO recognizes the need for adequate resourcing of the agricultural monitoring activities of member countries, to support sustainable agriculture development, addressing food security and climate variability

Summary

Links

- Trade and Markets Division (EST)
- Statistics Division (ESS)
- Climate, Energy and Tenure Division (NRC)
  - Climpag: http://www.fao.org/nr/climpag/
- Land and Water Division (NRL)
  - GAEZ: http://www.fao.org/nr/gaez/ (FAO internal only)
  - GLCN: http://www.glcn.org/