EuroGEOSS Agriculture pilot

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GEOGLAM/JECAM Co-lead
With the contribution of collaborators and leaders of several EU programs and projects

Washington DC, 23 October 2017

EuroGEOSS Agriculture Pilot - outline

1. EO Agriculture Monitoring - MARS, GEOGLAM and the current European contribution

2. Most recent European activities on infrastructure and Sentinels exploitation for agriculture

3. A way forward for a EuroGEOSS Agriculture Pilot to scale up and streamline the European contribution to GEOSS
Pioneering EO activity for Agriculture Monitoring

**EC MARS** program (JRC)
providing independent and timely information on crop production since 1988 from emerging technologies incl. EO

- **MARS Bulletin** for NRT Crop Monitoring and Yield Forecasting
  since 25 years for DG-AGRI, EUROSTAT, downloaded by 32+ countries

- **Food Security assessments** - EO based ASAP system & ad-hoc reporting DG DEVCO, EU delegations, FAO, WFP

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**GEOGLAM** – a flagship activity of GEO
endorsed and confirmed by G20 (Nov. 2011 till now)

- **Crop Monitor** as System of Ag Monitoring Systems for AMIS
- **Crop Early Warning** for food unsecured countries

- **JECAM** network as R&D component
**EuroGEOSS Agriculture Pilot**

**COPERNICUS 300m-1km products for agriculture**

More than 20 variables every 10 days at 300 m to 1 km with a world coverage ... to be used for crop monitoring, yield forecasting, biomass estimation

... disseminated through INTERNET and GEONETCAST system ...

... with currently more than 2,000 registered users in 66 countries

**European contribution to GEOGLAM & JECAM by**

**JECAM cross site experiments**

Yield estimations, Large field mapping, Small field mapping

**Infrastructure**

**EO indicators in crop yield forecasting**

How do (EO based) indicators from publically available global data sets perform in crop yield forecasting across different agro-environmental landscapes (JECAM sites)?

**Future integration in EuroGEOSS**

infrastructure -> STAC, ... integration of methodologies -> e.g.NextGEOSS capacity building validation data set (global)
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- Crop Monitor as System of Ag Monitoring Systems for AMIS
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**JECAM** network as R&D component

- EO requirements for Crop Monitoring to submit to CEOS
  Ad-hoc CEOS-GEOGLAM working group

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**EO Ag. Requirements to CEOS largely met by Sentinel satellites**

<table>
<thead>
<tr>
<th>Req</th>
<th>Spatial Resolution</th>
<th>Spectral Range</th>
<th>Effective observ. frequency (cloud free)*</th>
<th>Sample Type</th>
<th>Field Size</th>
<th>Crop Mask</th>
<th>Crop Type and Growing Calendar</th>
<th>Crop Condition Indicator</th>
<th>Crop Yield</th>
<th>Crop Biophysical Variables</th>
<th>Emiss. Variables</th>
<th>Ag Practices / Cropping Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100-200 m</td>
<td>Thermal IR + optical</td>
<td>Daily</td>
<td>Wall-to-Wall</td>
<td></td>
<td></td>
<td>SENTINEL-3: 300-1200m resolution, &lt;2 days revisit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>10-50 m</td>
<td>optical + SWIR</td>
<td>2 to 5 per week</td>
<td>Cropland Extent</td>
<td>All</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>L</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5-20 km</td>
<td>microwave</td>
<td>Daily</td>
<td>Cropland Extent</td>
<td>All</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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**Moderate Resolution Sampling** (10 to 100m)

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<tr>
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<th>Spatial Resolution</th>
<th>Spectral Range</th>
<th>Effective observ. frequency (cloud free)*</th>
<th>Sample Type</th>
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<tbody>
<tr>
<td>4</td>
<td>5-70 m</td>
<td>optical + SWIR</td>
<td>Monthly (min. 2 out of season + 2 in season, Required every 1-3 years)</td>
<td>Cropland Extent</td>
<td>All</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>L</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5-70 m</td>
<td>optical + SWIR</td>
<td>Weekly (min. 1 per 30 days)</td>
<td>Sample</td>
<td></td>
<td></td>
<td>SENTINEL-2: 10-60m resolution, 5 days revisits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10-100 m</td>
<td>SAR</td>
<td>Weekly (min. 1 per 2 weeks)</td>
<td>Cropland Extent of persistent (cloudy areas/rice)</td>
<td>All</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
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Source: CEOS Requirements for Agriculture 2012
**Copernicus space component**: a success story

- **Registered Users**: 99,049
- **Published Products**: 4,368,578
- **Volume of User Downloads**: 36.39 PB

status as of 18th of October 2017
EO and IT (r)evolution change the game for local, regional to national ag. monitoring

Change in user’s demand for
- big data access in NRT
- high resolution products in NRT
- multi-source integration in a seamless manner
- tailored EO-derived services for ag. management
- ...

Mobile internet for many
Global network with shared protocols

Free, open and long term data policy (EU)

Server farms for big data
Exploitation at low/no cost

3 platform projects handling big data flows

NextGEOSS
Agriculture pilots
‘Crop Monitoring Service’

Cloud-based processing: on-demand on user-request or subscription based

Data Analytics

NextGEOSS on-line demonstrations at the OGC/ESIP booth

food security tap

Food Security TEP Backbone
Earth Observation data & products
Federation of platforms
Tools & Methods

User

Community

Farmer

Industry

Agencies

Sciences

Mobile visualization in the field
Open expert interface

Food Security TEP Frontend

Customized products and services

aiming to integrate:
- Sentinels and UAVs
- Internet of things
- Crowdsourcing
- Deep learning algo

ANTARES

BioSense institute and WUR
Winter-Spring Rice 2015/16
• March 2016: 1.4 Million ha rice
• March 2015: 1.7 Million ha rice
16.5% loss in rice area due to drought & salt water intrusion caused by El Nino
⇒976,000 people affected, 67 Mil.$ estimated damage

The Mekong Delta, Vietnam
300 km x 300 km, 20 m resolution

Sen2Agri system: an open source system demonstrated at full scale NRT, running locally or on any cloud computing

Downloadable from www.esa-sen2agri.org/resources/software/
Composite series over Mali at 10m resolution from Sentinel-2 and Landsat 8

November 2016
50 days window
5/10/2016-25/11/2016

2016 Cropland mask at 10m resolution for Mali from Sentinel-2 and Landsat 8

System validation:
Overall accuracy: 94 %
F-score cropland: 80 %

Official ag stat survey as in-situ data
Sen2-Agri 10 m cropland map for Ukraine (July 2016)

Sen2-Agri 10 m main crop types map

**European long term programmes and assets:**

- Top class EO data sources thanks to Copernicus
- Pioneer world class operational crop monitoring at 300m-1km (MARS)
- World class EO research laboratories and rich in situ data in Europe
- Competitive EO know-how of private sector

**BUT**

*Fragmented project-based efforts prevent EO innovations from*
- having a **long term impact** on the EO ag. practices
- reaching a **critical mass** to create a significant market
- insuring **cumulative progress** from one outcome to another
- sustaining due to **multiple donors** with different mandates
- being adopted **by international initiative** like GEOGLAM

=> **potential impact of EuroGEOSS to sustain EO uptake**
To address the European users needs and upscale applications

- **DG-Agri & MS** for Common Agriculture Policy reform 2020+
- **Agriculture sector** like agri-business, insurance, ag. service,..
- **Food unsecured countries** or with emerging ag. sector
- **International partners** like GEOGLAM, JECAM, FAO, WFP

through these possible strategic activities

- **COORDINATE** - activities inventory, manage the redundancy, exchange between projects, between donors to build an European EO ecosystem for ag.
- **COMBINE** - cumulate R&D findings, scale up the success stories, and identify the R&D gaps
- **COOPERATE** - to join forces to propose an sustainable European contribution to internat. initiatives

**Potential element of EuroGEOSS Ag pilot**

JRC support to the CAP implementation and to its reform taking advantages of Sentinels

"knowledge that ensures efficient and consistent implementation of the CAP"
Potential element of EuroGEOSS Ag pilot
Sen4CAP

Close collaboration between EU DGs, Member States and ESA to exploit Sentinels for Common Agriculture Policy (current and 2020+)

- Paying Agencies & Farmers
- DG-Agri, JRC, DG-Grow
- EO Experts

Continuous Monitoring
Validated Performance
National Demonstration
Innovative Practices

Coordination of a best practices compendium to capitalize GEOGLAM & JECAM the findings of SIGMA and Sen2Agri

Support the European component of JECAM network to develop ag. services for the European cropping systems (collaboration between 5 sites – DE, F, SP, BE, PL,...)

More than 30 sites globally distributed with regular in situ data collection

JECAM GOALS

The overarching goal of JECAM is to reach a convergence of approaches, develop monitoring and reporting protocols and best practices for a variety of global agricultural systems.
Coordination of a best practices compendium to capitalize GEOGLAM & JECAM the findings of SIGMA and Sen2Agri

Support the European component of JECAM network to develop ag. services for the European cropping systems (collaboration between 5 sites – DE, F, SP, BE, PL,...)

Advanced service example developed on the BE JECAM site

Nitrogen Nutrition Index for all winter wheat fields (Southern Belgium) from Sentinel-2

(Delloye et al., submitted RSE2017)

Potential element of EuroGEOSS Ag pilot

Sen2Agri uptake

Sen2Agri to provide national monitoring system

Open Source

Cloud Technology (IPT / EODC / DIAS)

Fully scalable
Close to the Data (reduced bandwidth)
Continuous Monitoring
Operational context (e.g. timeliness)

South Sudan (Sept. 2017)
Contribution to the EuroGEOSS Ag pilot
EO4SD-Agric.

EO for Sustainable Development to mainstreaming EO into development bank activities

Addressing several thematic areas across 9 countries
1. Monitoring agricultural production
2. M&E of land degradation
3. Agricultural commodities production’s impact assessment
4. Ecosystem services provided by agriculture
5. Planning and monitoring of rural infrastructure investments
6. Food security and agriculture risk management
7. Support environmental and social safeguards frameworks
8. Irrigation systems development and management

On-going element of EuroGEOSS Ag pilot

Lessons learned for EO service development

- **User demand driven**: adding value for customer
- **Business/revenue model** to reach sustainability, e.g.
  - Freemium business model (services paid by B2B customers)
  - Inclusive business model: with credit, seed, fertilizer provision
- **Aggregator to reach scale**
  - Local input supplier
  - Local commodity trader
- **Govt support needed**
  - Extension officers
  - Subsidies on premium
  - License to operate

https://g4aw.spaceoffice.nl
On-going element of EuroGEOSS Ag pilot

Insurance of credit provision for 1.5 million farmers (Ethiopia)

Agro advice for 400,000 farmers (Vietnam)

Forthcoming element of EuroGEOSS Ag pilot

Enhancing Food Security in AFRICan AgriCULTUral Systems with the Support of REMote Sensing (H2020)

Innovative fusion of data from multiple sources (EO, in-situ, citizen-based crowdsourcing, climate services and weather, crop models)

Enhanced crop yield and biomass prediction models, emphasizing the use of the complementary sensors of the EU Sentinels constellation

Spatial Decision Support System (DSS) to enrich decision making and risk assessment and web tool that will support early decision making

Partnership between eight African and eight European partners, African collaborating networks, local training, cooperation with AfriGEOSS
EuroGEOSS is a triple opportunity for the European EO community:

⇒ to **speed up and upscale** the most promising EO applications for the agriculture sector, including in the complex European cropping systems
   
   e.g. a financing mechanism to leverage EU project final outcomes till the effective uptake by users

⇒ to **consolidate the European know-how and innovation capacity** of the EO research & private sector ecosystem
   
   e.g. (bi-)annual meeting of European EO agric. community to exchange on experience of products and services developed by various projects supported by various donors

⇒ to provide a **sustainable and coherent contribution** to international initiatives (GEOGLAM and JECAM)
   
   e.g. through the support of coordination of the European contribution to GEOGLAM and JECAM

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**Great success to EuroGEOSS**

Thanks to Michel MASSART (EU-DG-Grow) for Copernicus

Veselin Crnojevic (Biosense) for Antares

Cindy Delloye (UCLouvain) for BELCAM

Erwin Goor and Sven Gilliams (Vito) for the NextGEOSS and SIGMA

Eskien Volden (ESA) for the EO4SD, GeoRice and Food TEP

Rued Grim (Netherlands Space Office) for G4AW

Juan Suarez Betrian (GMV) for AfriCultuReS

Sophie Bontemps and Nicolas Bellemans (UCLouvain) for ESA Sen2Agri and ESA Sen4CAP