GEOGLAM's
Earth Observation Requirements
R&D Outcomes to
Operational Requirements and Guidance

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Outline

- EO Data Requirements
  - Background, status, direction - **DISCUSSION**

- Other matters:
  - Data Request Submission Tool
  - Coordination of restricted data sets – e.g. Pleiades
  - Commercial dataset offerings – e.g. Digital Globe & UrtheCast
  - Data Cube

GEOGLAM Requirements – Version 1 (2012-2014)

- Cropping systems are inherently diverse and dynamic
- No single mission can meet the variety of EO requirements (spatial, temporal, and spectral diversity)
  - But coordinated acquisition by missions (e.g. from multiple agencies) can greatly enhance agricultural monitoring

- Agricultural Monitoring Community had many common issues of data frequency, timeliness, policy, availability, and continuity
- In this context, GEOGLAM developed Earth Observation Requirements for agricultural monitoring …and conducted an analysis of present/future missions' capacity to meet these requirements

GEOGLAM CEOS Workshop on OBSERVATION REQUIREMENTS
CSA, Montreal July 10-11, 2012

Tabulating the satellite observation requirements
(spatial resolution, frequency, and period of coverage)
for GEOGLAM

Req #	Spatial Resolution	Spectral Range	Effective observ. frequency (cloud free)	Extent	Field Size	Crop Mask	Crop Type Area and Growing Calendar	Crop Condition Indicators	Crop Yield	Crop Biophys. Variables	Environ. Variables	Ag Practices / Cropping Systems
Coarse Resolution Sampling (>100m)												
1	500 - 2000m	optical	Daily	Wall-to-Wall	All			X		L		
2	100-500m	optical	2 to 5 per week	Cropland extent	All	X	X	X	L	L	X	L
3	5-50 km	microwave	Daily	Cropland extent	All			X	X	X	X	
Moderate Resolution Sampling (10 to 100m)												
4	10-70m	optical	Monthly (min 3 in season + 2 out of season); Required every 1-3 years	Cropland extent (if #5 = sample, else skip)	All	X	L/M					X
5	10-70m	optical	8 days; min. 1 per 16 days	Sample (pref. Cropland extent)	All	X	X	X	X	X	X	X
6	10-100m	SAR	8 days; min. 1 per 16 days	Cropland extent of persistantly cloudy and rice areas	All	X	X	X	X	X	X	X
Fine Resolution Sampling (5 to 10m)												
7	5-10m	VIS NIR + SWIR	Monthly (min. 3 in season)	Cropland extent	M/S	M/S	M/S					
8	5-10m	VIS NIR + SWIR	Approx. weekly; min. 5 per season	Sample	All		M/S	X		X	X	X
9	5-10m	SAR	Monthly	Cropland extent of persistantly cloudy and rice areas	M/S	M/S	M/S					M/S
Very Fine Resolution Sampling (<5m)												
10	< 5m	VIS NIR	3 per year (2 in season + 1 out of season); Every 3 years	Cropland extent of small fields	S	S	S					
11	< 5m	VIS NIR	1 to 2 per month	Refined Sample (Demo)	All		X		X			X

Need for an update

- Incorporating JECAM site results
  - Space based
  - In situ / agrometeorological
- New data streams – *SAR not well accounted for*
- Increasing geographic /landscape complexity
- Instituting priorities
  - Minimum vs. preferred
  - Locations (e.g. Waldner et al. 2015) – priority agricultural areas?
- Unanswered questions
  - How do we account for field size, spatial pattern, and heterogeneity (Duveiller & Defourny, 2010)?
  - How to coordinate between optical + SAR?
  - How much can be achieved without good *in situ* or vice versa?

Support from JECAM Sites

- Filling out excel sheet
  - ***Please be precise***
  - Minimum vs. preferred datasets, methods for different applications, accounting for accuracy desired vs. achieved
  - Beginning to bridge from research to operations
  - Toward "Methods and Guidance" type documentation

- Participating in SAR intercomparison study
  - e.g. AAFC/UMD collaboration looking at crop type classification accuracies at varying cloud coverage
    - *"how cloudy is too cloudy for optical, and where can SAR fill in the gaps?"*

Example Responses: CROP TYPE

- Variability between sites – perhaps we could group (discussion point)?
  - Sensor specifications: based on crop type heterogeneity, field size, climatology… are data availability or dataset familiarity factors?
  - Big differences in latency (1 week to "by end of season"), and when product needs to be generated.

- Vague specifications on field data
  - Discussion needed on where to go with this

	Burkina Koumbia		Mekong Delta		Belgium	
	Minimum	*Prefered*	*Minimum*	*Prefered*	*Minimum*	*Prefered*
What kind of satellite imagery were used or are viewed as necessary? *(Spatial + spectral characteristics)*	One VHSR scene (<2m e.g. Pléiades or Spot6/7) Optical HSR dense time series (~10m, e.g. pansharpened Landsat-8 data or Sentinel-2) for full growing season	Additional VHSR time series along and across the agricultural season. The use of radar data for crop-type characterization is currently under investigation.	Time series SAR data	Time series S1 +S2	Radarsat 2 Fine-QuadPol; High resolution (10m) MS (GREEN,RED,NIR,SWIR)	Radarsat 2 Fine-QuadPol; High resolution (10m) MS (GREEN,RED,NIR,RED EDGE, SWIR 1,2)
How often were these imagery required? *(e.g. scenes per season, or interval between images) - specify cloud coverage if applicable*	Current acquisition (cca 20 images over AGS with <40% cloud coverage) is not enough	Maximum possible acquisition frequency of optical and radar data along/across AGS	Minimum 4 scenes per season	Time series SAR data (S1) and optical data (S2)	1 optical cloud free and SAR image per 2 months	1 optical cloud free and SAR image per month
What kind of field data were collected or are viewed as necessary? *(describe sampling strategy if applicable)*	Land cover GPS data (using a slightly modified version of the JECAM nomenclature) collected via field campaing, in the most scattered way over the site considering the ease of access to crops.	As for crop mask, with additional information on crop health status, practices and sowing delays (needs inquiry of peasants).	Random selection of rice and other crops	Random selection of rice and other crops using a regional sampling scheme	Crop Map (crop type & field boundaries)	Crop Map (crop type & field boundaries)
What kind of agrometeorological data were used or are viewed as necessary?	None.				rainfall (to potentially discard SAR image from the series)	rainfall (to potentially discard SAR image from the series)
What data latency was required? *(how long can you wait between acquisition and data access?)*	before beginning of the next agricultural season	when approaching the end of the season	1 month	10 days	until 2 months (as no real time analysis)	until 2 months (as no real time analysis)
What analytical method was used to derive the target product?	OBIA approach: object layer extraction at sub-crop scale using VHSR imagery, object based feature extraction and		For rice/non rice map, using temporal change of S1(and S2)		pixel based supervised classification (RF)	
What was the target accuracy of the products produced?	Overall accuracy above 80%		90%		> 0.8 Overall accuracy, >0.5 accuracy for each main crops	
What was the accuract of the products produced?	Overall accuracy ranging from 76,5% (level B) to 69,3% (level D) (last season processed May-Nov 2014)		97 % in a test with 120 samples		match (above 0.8 for each strata except some crops around 0.6)	
What were the primary sources of error?	Incomplete data due to cloud coverage. Time series spatial resolution to low w.r.t. average crop sizes. Time series spectral resolution insufficient to separate close crop types without further information.		Error in Coordinates between in situ and maps		Natural variability between fields and within varieties, sampling issues (proportionnal abundances)	
At what point in the agricultural growing season do you require this	End (ideally slightly before end)		Maximum 1 month after the beginning of the season		Mid- and end of season	
At what point in the agricultural growing season were you able to generate the product?	During next agricultural season.		Locally: after 3 data takes (S1: 1 months).For shifted calendar regionally: 2 months		End of season	

Discussion Questions (1)

- Are the variables in the Excel sheet those on which we should focus?
  - Crop type; crop mask; LAI; biomass
  - Crop forecasting & estimation have similar requirements… merge?
  - Soil moisture? **OTHERS?**
  - Is crop phenology a different variable, or implied in others?

- What research questions need to be addressed in order to refine the requirements?
  - SAR + optical fusion
  - How to/should we account for spatial heterogeneity in landscapes?
  - Others?

Discussion Questions (2)

- Would replacing simple field size breakdown (S, M, L fields) with "cropping system" be enough of an improvement to counter-balance the added complexity?
  - What would those cropping systems be, how to break down?
    - *Field size, # of cycles per year, landscape variability, cloud coverage…*
    - *[implications for scaling up beyond site level]*

- Do we have enough results from diverse enough sites (including Asia-RiCE) to advance the requirements specification?
  - Some request lots of optical because of clouds – why not use SAR?

- What to do when requirements between sites (even of similar "cropping system") are *very* different?

Discussion Questions (3)

- For "Methods and Guidance" documentation:
  - Do we want to specify a minimum sampling strategy?
  - Do we want to "endorse" or report on specific methodologies used?

- Any interest from JECAM sites to participate actively in refining the requirements, or in "methods & guidance" documentation / training materials development?

- How can we streamline the process of updating requirements?

Next Steps

- Send out revised Excel sheet (for use by those who have not yet responded) – *if necessary (based on discussion)*

- Follow up with JECAM sites about any questions/clarifications/additional information

- Task force of the willing to collaborate on this effort

OTHER EO DATA COORDINATION MATTERS

GEOGLAM's Data Request Submission Tool (1/2)

What? A mechanism for GEOGLAM community members to communicate their space-based EO data needs to the GEOGLAM Secretariat & onto data providors

- ❑ Forward looking (new) data needs
- ❑ Backward looking (archival) data needs
- ❑ …so that GEOGLAM can work with CEOS and space agencies to meet GEOGLAM's needs

Why?

- ❑ The <u>first step</u> in a pipeline to request and obtain space-based EO data for agricultural monitoring applications (e.g. crop conditions, crop yield forecasting & estimation, cropland & crop type mask, crop calendars) – coordinated data for GEOGLAM.
  - ❑ A request ≠ a guarantee of fulfillment

Who?

- ❑ Requests *from*: Remote sensing analysts who participate in GEOGLAM who need support in discovering, requesting, and/or obtaining space-based EO data
- ❑ Requests *to:* GEOGLAM Secretariat, CEOS, and the space agencies

Which Data?

- ❑ New Acquisitions: any mission currently operational from a civil space agency
- ❑ Archival Data: a few missions currently available, working to expand (see next slide)

Submit requests here: https://goo.gl/dmV87v

GEOGLAM's Data Request Submission Tool (2/2)

How?

- **Step 1: Submit requests here:** https://goo.gl/dmV87v
    - *Which data (spectral/spatial resolution), when, where, how frequently?*
    - *For what purpose?*
    - *Do you need help with downloading, storing, or pre-processing data?*
- **Step 2: GEOGLAM Secretariat & CEOS Ad Hoc WG evaluate submissions**
    - *For archival data requests – we search the metadata archives to see what exists, then submit requests to agencies*
    - *For new acquisition requests – we evaluate capabilities to meet requirements, and request acquisition plan modifications to accommodate them*

When to submit requests?

- **Starting now, only when you are ready and willing to use the data**
- **Data readiness definitions:**

    - *Level 1: You have the desire and capacity to analyze the satellite data, but lack the capacity to download, store, and/or preprocess data for use. Therefore, a data services solution is desired to manage any data.*

    - *Level 2: You have the desire and capacity to download, store, preprocess, and analyze satellite data, but require CEOS intervention to do so (including: mode selection, coverage expansion, license assistance, etc.).*

    - *Level 3: You have the desire and capacity to download, store, preprocess, and analyze satellite data, but you require NO intervention on the part of CEOS (no new acquisition requests or aid in securing archival datasets).*

Commercial and Restricted Data Access

- **Pleaides (Airbus, collected for us with CNES support)**
  - Up to 20,000 sq km per year
  - We need to prioritize – who wants to participate?

- **Digital Globe**
  - <1-4 meters pan or multispectral data; free over JECAM sites

- **UrtheDaily (UrtheCast)**
  - Daily, 5-meter resolution in R, G, B, NIR and 2 RedEdge bands
  - Subscription based (pay per GB) – enroll now, get data in 2019:

Tier	Data Cap* (GB/mo)	≈Price (USD/GB)	≈km² Cap (km²/mo)	≈Price/km² (implied)	≈Average km² (every 2nd day)	Example AOIs (if accessed every 2nd day)
Platinum	25,000	$20	50.0M	$0.01	3,333,333	India, Argentina
Gold	10,000	$30	20.0M	$0.015	1,333,333	Peru, South Africa
Silver	4,000	$38	8.0M	$0.019	533,333	Spain, Sweden
Bronze	1,500	$50	3.0M	$0.025	200,000	Tunisia, Bangladesh

Data Cube

- CEOS is developing a raster-block data storage, access, and visualization "Data Cube"

- Multiple, pre-processed, "analysis-ready" data sets
  - Coincident/co-located with one another, enabling deep time series generation…

- Opportunity to do one over JECAM sites, but funding required (esp. if incorporating restricted/commercial datasets)

Backup materials